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ON FORESTS AND TREE GROWTH IN THE KNOB LAKE AREA, QUEBEC-LABRADOR PENINSULA

BY

ILMARI HUSTICH

HELSINKI—HELSINGFORS 1954

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Introduction.

The Knob Lake area (see Fig. 1) was visited by the author in 1948, from August 8 to September 4.

The author's studies in 1948 were supported by the National Museum of Canada jointly with the Arctic Institute of North America. This was made possible by the kindness of the Chief Botanist, Mr A. E. PORSILD, Ottawa, and the Director of the Arctic Institute in 1948, Dr A. L. WASHBURN.

For the generosity shown by the General Manager of the Labrador Mining and Exploration Company, Mr. W. R. DURRELL, in enabling me to visit this interesting part of the unknown interior of the Labrador Peninsula, I express my sincere gratitude. Mr. J. LITTLE, Superintendent, Dr. J. A. RETTY, the staff and workers at the mining camp at Burnt Creek in 1948 helped the author in many ways, as did Mr. H. GATES, the pilot.

General forest-botanical notes from the area have previously been published by the author (1951a and 1951b). This paper gives i.a. some additional information, particularly of tree growth measurements, and follows in general the same pattern as my paper (1950) in Acta Geographica 11 on the forests and trees on the Hudson Bay east coast.

The purpose of this paper is mainly to give a first impression of a virgin forest area. However, we know so little about the subarctic forests that even a paper like this can be of some use for further exploring.

Helsingfors, November 2nd 1953.

I. H.

General remarks on the Geography and the Vegetation.

The Knob Lake area lies on the northern and eastern border of the central watershed region in the interior of the Quebec-Labrador Peninsula. Knob Lake Meteorological Station is situated at 54°50′ N and 66°42′ W; elevation 1550 feet. The average altitude is approximately 1800 feet above sea-level. The highest mountain massif in the area, Irony Mountain (about 3000 feet), is probably the highest mountain in the Labrador interior, with the possible exception of the mountains near Goodwood (NW of Knob Lake) and the Otish Mountains S of Nichequon.

The area is topographically characterised by rolling low mountain ridges and sand and gravel eskers, running for the most part NW—SE. Between the eskers and ridges there are often narrow lakes and swamps. The topography is dominated by the structural trends of the Precambrian sediments. For a general description of the »Labrador Trough», i.e. the belt of folded sediments from Hamilton River to Ungava Bay, compare HARE 1952. The precambrian sedimentary bedrock is of great phytogeographical importance. The vegetation in this area seems to be richer and the tree-growth more luxuriant than in the surrounding granite-gneiss area.

The Pleistocen ice had its centre in this terrain. The ice overrode the area leaving glacial till of heterogeneous composition, thus making the influence of the bedrock itself on the vegetation very complex. Sand plains and terraces produced by the melting ice are common and — from the air — easily distinguished by their characteristic cover of spruce lichen forests, common all over the interior of the Peninsula.

The climate of the interior is still largely unknown. The author has not got the temperature or precipitation series from

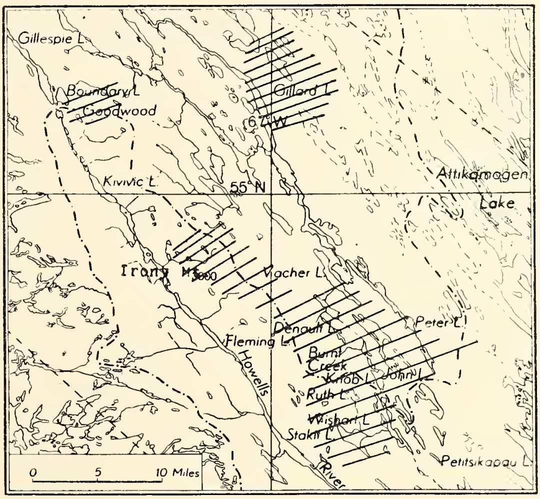

Fig. 1. The Knob Lake area in the interior of the Quebec-Labrador Peninsula. The shaded area visited by the author in 1948.

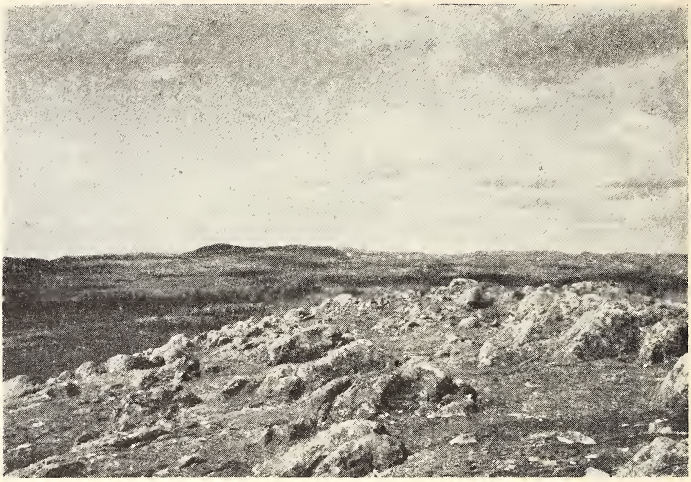

Fig. 2. The mountain terrain around Burnt Creek.

Knob Lake Meteorological Station. HARE (l.c.) mentions that the mean July temperature is 57°F (14°C), the January temperature near —10°F (= —23°C). The summer temperature is higher here than along the coast at the same latitude, because of the higher continentality, but the winters are cold. The annual snowfall is 100—125 inches. Snow patches were visible only in a few places in August on the Goodwood mountain plateaux. These snow patches melted in 1948 late in August. Judging from the spruce trees and from the height of the ground birch scrub the snow cover in the lowland is generally 5 to 6 feet in more sheltered places. No specific observations were made of permafrost. Permafrost is, however, reported from Kivivic Lake (JENNESS 1949), see Fig. 1, about 2500 feet above sea level. However, the sudden lowering of the water level in small ponds late in August was probably due to the late melting of the ground ice in the bottoms of the ponds. One of the geologists at the camp mentioned that permanent ice was found in the beds of weathered iron formation 60 feet deep. MUNROE (1949) reports that the ice on the lakes breaks up in June and is re-formed in October. Thus the climate is severe, in spite of the fairly southern situation.

The area is situated between the taiga proper and the forest-tundra (compare HARE 1950 and H 1949[1]), or, using a recent terminology, between the subarctic and the hemiarctic (ROUSSEAU 1952).

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[1] The expressions »H 1939», »H 1949», etc. refer to the authors earlier papers, see p. 58.

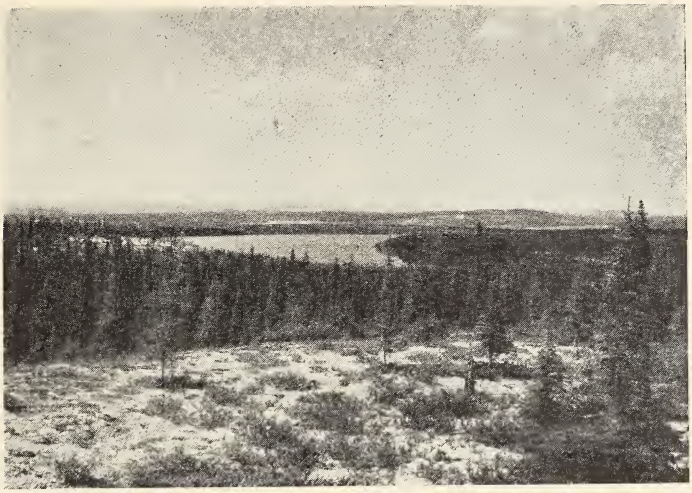


Fig. 3. View towards N from a hill S of Lake Gillard.

The varying topography causes great variations in the vegetation, which ranges from luxuriant fens and rich white spruce groves to alpine heaths on the higher mountains. The treeless heaths on Irony Mountain and its surroundings show a great resemblance to some mountain areas in Swedish and Finnish Lapland.

The type of bedrock common here causes an abundance of small fens with a flora rich in grasses and herbs and scattered tamaracks. Smaller bogs with a more trivial flora may also be seen in the area. The author, however, did not see in the area any large »string bogs» which seem to dominate the granite-gneiss area outside the sedimentary belt (judging from air-trips Seven Islands—Knob Lake and Seven Islands—Goose Bay). No »palsa»-bogs, described by WENNER (1948) and the author (1939) from the Labrador coastal districts, were seen. The lakes are mostly very clear, visibility up to 9—12 feet, and seem to be inhabited by an aquatic flora poor in species.

The catalogue of vascular plants (H 1951a) collected in the area in 1948 comprises 253 species and varieties. This first nearly complete list of plants from the interior of the Peninsula was, of course, rather incomplete owing to the short time the author could spend there. DUTILLY, LEPAGE and DUMAN (1953) report 283 species from the Fort Chimo area. Re the general botanical investigation of the different parts of the Labrador peninsula, compare ROUSSEAU (1952). The flora is poor in the interior of the peninsula probably due to the the late retreat of the Pleistocen ice (later than in Scandinavia?).

The influence of man on the vegetation, at least in 1948, was not yet very strong. No »anthropochore plant» was found in the area 1948, the reason being that the base camp was supplied entirely by air (compare Porsild 1945). There had been fairly extensive forest fires in the surroundings in recent years, but practically no cutting had taken place at that time (1948). The recent »boom» in this new iron area has been described i.a. by Retty 1951.

II. The Tree Species.

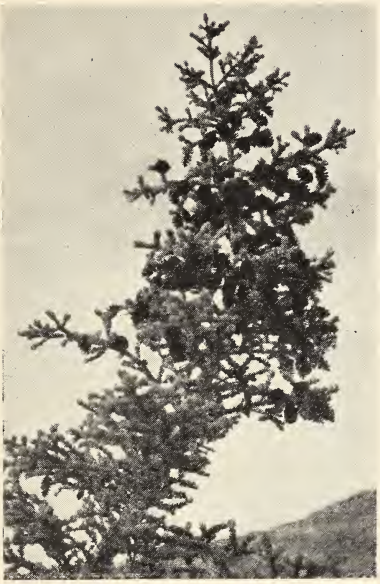
The area lies outside the northern limits of Banksian pine and cedar (see the tree-line maps in H 1949). The dominant tree species are black spruce, white spruce and tamarack. Balsam fir is not as common here as further south. Paper birch occurs on some slopes and balsam poplar is found rarely in groves. Re aspen, see below p. 11.

White spruce usually grows more luxuriantly and in richer habitats than black spruce. It is, however, also common here and there in seemingly poorer habitats, often forming white spruce lichen heaths. White spruce attains in the area a maximum height of 60 feet (near sample plot 16) and a diameter of about 35 inches. About 300 years old white spruces (one tree 282 years at breast height) were measured.

On pure iron formation there seemed to be little white spruce; the species was common where the influence of dolomites, shales etc. was more marked. Thus, the common occurrence of white spruce in the area is probably primarily attributable to the sedimentary bedrock. In suitable habitats the radial growth of white spruce in the area is 2.5—3.0 mm; for the normal radial growth compare Table VII.

Here as on the east coast of James Bay and Hudson Bay white spruce seems to be hardier than black spruce (see the note above on the semi-tundra on the slopes of Irony Mountain).

The mountain white spruce in the area sometimes shows astonishingly good growth; the same feature is observed on the mountain slopes in the interior mountain areas in northern Scandinavia and Finland. One of the reasons is the good drainage, another the greater humidity on the slopes and, in this case, also the type of bedrock with its greater lime-content than in the granite-gneiss-area. The good growth is, however, restricted to radial growth rather than to the growth in length. (In Lake Melville area spruce (black or white spruce?) reaches 100 feet (Kindle 1924) in height and 9 feet in circumference.)



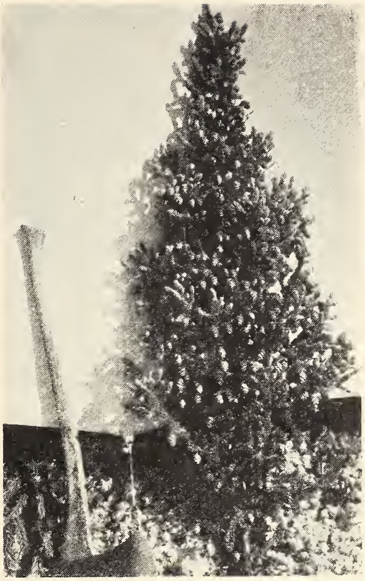


Fig. 4. Tree-line white spruce with rich production of well opened cones (Burnt Creek).
Fig. 5. Top of a 27 foot high, about 100 year old black spruce from a lichen forest near Lake Gillard.

Black spruce is commoner than white spruce on more acid and »poorer» soils, e.g. on iron formation bedrock in the area. Black spruce lichen forests with rather low old trees growing scattered, often with a heavy cover of black beard lichens, are common. Also, black spruce often reaches the habitus of »candelabrum-trees», earlier described by the author (H 1949, 1950); compare also Dutilly and others 1953. (White spruce in the area does not form candelabrum trees, i.e. several stems rising from the same low ground trunk; only one such white spruce was seen.)

The common taiga forest type, black spruce muskeg, is not very typically developed here since stagnant terrains with rather acid soil are not very common in the area. My impression is that the typical black spruce muskeg (H 1949) seems to be restricted to the granite-gneiss area.

Black spruce in the area attains a maximum height of about 48 feet and a diameter of about 20 inches d.b.h. At least 250—300 years old black spruces (two trees 240—250 years at breast height) were seen.

The difference between the two spruce species in the area investigated was noted in the field as follows:

White spruce reaches greater size, grows in »richer» habitats and does not form adventitious roots or »candelabrum»-trees. The branches are usually horizontal when the tree grows on dry habitats. The glossy twigs are usually clear or pale green, the bark light greenish and fairly smooth. The needles are about 8—10 mm, the cones 3—4 cm long.

Black spruce often forms candelabrum-trees and frequently has adventitious roots. The branches of the black spruce trees are usually turned a little upward when growing on dry habitats. The hairy twigs are mostly darker, slightly brownish, the bark is rougher. The needles are generally 6—8 mm long and the cones, clustered in the top of the trees, 1.5—2 cm long. The characteristics of the black spruce given by LE BARRON (1948) seem to hold good also in this district. Well-grown young black spruce can, however, sometimes have glossy terminal annual shoots.

Information on the reproduction of white spruce and black spruce is given on p. 32. As to the quantity of seedlings, no real difference between the species could be established.

Compared with other areas in Labrador that the author has visited, the Knob Lake area seems to be richer in *tamarack*. The impression is probably due to the abundance of fens and swamps, i.e. habitats where scattered tamaracks always occur. This abundance of fens and swamps (bogs have a poorer, »acid» flora, on *Sphagnum*, than fens; compare also MOSS 1953) is mainly due to the quality of the bedrock and the topography of the area. Tamarack is also fairly common on drier habitats; patches of tamarack-dominated lichen forests were also found. (P. 176 in H 1951a gives a wrong impression of the above observation). Tamaracks in the area reach a height of about 35 feet and a diameter of 10—12 inches. No accurate age measurements were made. The oldest tamarack measured was 137 years at breast height. Cone and seed production of tamarack seemed to be satisfactory, as shown by the relatively large number of seedlings which were noted in many habitats, particularly in swamps. For the age determination of tamarack seedlings, see p. 32. The old tamaracks on the higher slopes have the same twisted (counter clockwise) trunk as the old pines in the forests in Lapland.

Balsam fir occurs only here and there in the area, but where it does occur it often forms very dense thickets along brooks. It is also found in well-drained depressions in white spruce forests, etc. Balsam fir was found in several places near Lake Gillard, Burnt Creek, Knob Lake and Ruth Lake. The staff at the base camp mentioned that balsam fir also occurs at Sunny Lake and at Eclipse. The variety *Abies balsamea* var. *nephrolepis* Fern. was not noted by the author in the area.

The largest balsam fir noted was about 40 feet in height and 8 inches in diameter. The oldest tree measured was only 82 years at breast height. The striking characteristic here as in other parts of Labrador was the strong vegetative reproduction capacity of the species (compare H 1950, p. 30). Only 3 balsam fir seedlings, 4—5 years old, were noted during the excursions.

Paper birch or *white birch*, of considerable size (largest 24 feet in height and about 20 inches in diameter at the ground) was found only on the northern slope (iron formation) of the low mountain W of Lake Denault. (The locality is described in H 1951a, p. 192—193). The birches in this area, as generally in the northern taiga, belong to the variety *Betula papyrifera* Marsh.var. *cordifolia* (Regel) Fern. Rich fructification was noted on the birches, which were all rotten; age was impossible to determine. Smaller trees of the same variety were found 1 mile S of Burnt Creek. Birch seem to be more common in the granite-gneiss area than in the Precambrian sedimentary belt (compare p. 208—209 in H 1951a). (Rich birch groves occur near the Kaniapiskau River NW of Burnt Creek in the granite-gneiss area.)

Balsam poplar was seen only twice. One locality was pointed out by a worker at the base camp and lies at the northwest end of John Lake (see p. 192, H 1951a) in the upper part of the forest region. Balsam poplar was also found at the opposite end of the same lake; the poplars were at most 30 feet high and 12 inches in diameter. Propagation was vegetative only and no reproduction by seed was observed. The trees were young, about 25—35 years at the ground. Re the distribution of balsam poplar in Labrador, compare i.a. H 1949, H 1950 and DUTILLY et al. (1953), who described its occurrence in the Fort Chimo-Koksoak district. The variety *subcordata* Hyl. (= var. *Michauxii*) of balsam poplar was not noted by the author; it is however mentioned by Dutilly et al. (l.c.) from Fort Chimo.

Aspen was not seen in the area. According to a verbal communication from Mr. R. N. DRUMMOND, Montreal, aspen (det. MARCEL RAYMOND) grows along the Kaniapiskau River between Maniton Gorge and Fort Mackenzie. Thus the northern limit of aspen goes farther north in the interior of the peninsula than was earlier recorded by the author (H 1949). Aspen grows abundantly near Lake Melville. It belongs to the granite-gneiss area rather than to the sedimentary bedrock. ST. JOHN gained the same impression from the North Shore area (1922).

*

The author's impression was that the tree-species in the Archaean granite-gneiss area around the Knob Lake-area are mainly black spruce, balsam fir, tamarack, white birch and aspen and speckled alder, and in the less acid sedimentary bedrock areas white spruce, tamarack, black spruce, balsam fir, balsam poplar, white birch and alder (*Alnus crispa*). The influence of the Precambrian bedrock in the Labrador Trough is also marked in the Hamilton valleys eastwards. The dependence of white spruce on the quality of soil in the northern taiga was noted by LOW as early as 1894. It must also be noted that particularly the white spruce reaches, as can be seen in the notes from the sample plots, a good size and has a good radial growth in some isolated stands on sheltered mountain slopes in the Knob Lake area that rise like islands above the surrounding lower mountain forests.

III. The Bush Species.

The commonest bush in the Knob Lake forests is the dwarf birch species, *Betula glandulosa* Michx., which occurs in almost every forest type. It usually attains the height of the snowcower, sometimes up to 5—6 feet. It can be regarded as a pioneer species in the spruce lichen forests; it slowly adds to the shadow over the lichen, thus inviting other elements (for instance, feather mosses and dwarf shrubs) into the lichen forest.

The other birch species mentioned below (det. A. E. PORSILD) are of minor importance. *Betula minor* (Tuckerm.) Fern. grows fertile on subalpine slopes, together with alder and dwarf birch, but does not form a birch belt. The species only reaches a height of 3—9 feet. Collected from eight different places in the area; it seems to be more common here than in other parts of Labrador visited by the author. It is the east-Canadian counterpart to the Scandinavian subalpine birch species (*B. tortuosa*). *Betula pumila* L. var. *renifolia* Fern. was found once in a rich swamp and the same applies to the rare, foot-high dwarf birch species *Betula Michauxii* (compare ROUSSEAU and RAYMOND 1950). *Betula borealis* Spach, 8—11 feet high, was collected near Burnt Creek on a stony iron formation slope. The birches often form hybrids; there are also such sheets in my collection of 1948 (compare LEPAGE 1952).

Of great importance from the forestry point of view is the alder, *Alnus crispa* (Ait.) Pursh. It is very common along brooks and creeks and on lake shores. Sometimes it occurs in moist forests or on mountain slopes, here more often with white spruce than with black spruce. The alder is a pioneer species; alder bushes slowly give way to spruce forests. On the other hand, it rapidly conquers »open» places. Its capacity to build up the nitrogen content of the forest soil is well known. The alder grows about 15 feet high, usually 2—3 inches in diameter. The age of such »trunks» seems to be about 30 years. The alder showed rich fructification in 1948. The alder variety *A. crispa* var. *mollis* Fern., with thinner, slightly hairy leaves (the degree of hairiness varies) is probably only a form of *A. crispa* growing in less exposed localities than the main form, which has smaller and thicker, more or less glossy leaves. No typical var. *mollis* was seen in this area.

Speckled alder *A. rugosa* (DuRoi) Spreng. var. *americana* (Regel) Fern. does not occur in the area, but was common at Ashuanipi Lake (200 miles S of Knob Lake) and at Goose Bay, etc. This alder species is restricted to the granite-gneiss area.

The ground vegetation in the alder thickets is usually more luxurious than in the surroundings (compare H 1950 and H 1951a and sample plot 13 below). Dense alder belts were no common feature in the area above the spruce forest (compare PORSILD 1939 and p. 17 below)

Salix Bebbiana Sarg. is probably the commonest of the forest willows (det. A. E. PORSILD) and reaches tree-size, in some places growing about 27 feet high and 5 inches in diameter (No. 845 in my Knob Lake collection in Nat.Mus. of Canada) i.e. the same size as white birch and poplar in the area. Its pattern of occurrence and its habitus is as far as I know very similar to that of *Salix caprea* L. in the North European taiga forests but the species itself more closely approximates *S. depressa* (compare HIITONEN 1950). Other common willow species in the forests are *S. pedicellaris* Pursh. var. *hypoglauca* Fern. and *S. planifolia* Pursh. (which reaches about 12 feet in height and 2 inches in diameter.) They are closely linked to the European *S. myrtilloides* and *S. phylicifolia* according to HIITONEN (l.c.). Re other *Salices* collected in the area, compare RAUP 1943.

The juniper (*Juniperus communis* var. *depressa*) occurs sporadically; it prefers sunny cliffs on mountain slopes but is found also on flat dolomite rocks in spruce forest and on open lichen heaths.

Of bush species, which in the southern part of the taiga are rather common in the forests, only the following occur (rarely) in the Knob Lake area: *Sorbus decora* (Sarg.) Schneid. var. *groenlandica* (Schneid) Jones, *Amelanchier Bartramiana* (Tausch.) Roem., *Cornus stolonifera* Michx. and more common *Viburnum edule* (Michx.) Raf. Re *Ledum*, *Ribes*, *Myrica* etc., see H 1951a.

Generally speaking, the bush species are of markedly less importance in the northern taiga and in the forest tundra than in the southern spruce region.

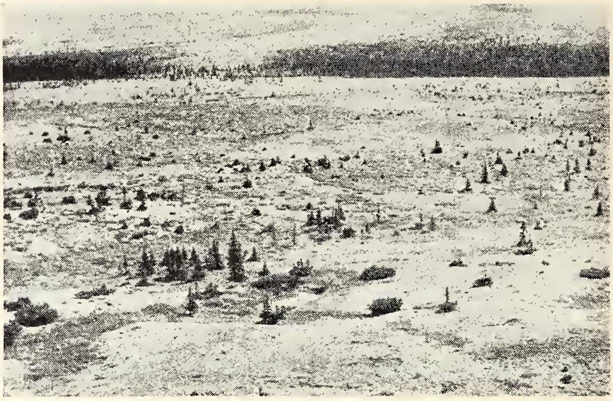


Fig. 6. Open »semi-tundra» on the E slopes of Irony Mountain. The low shrubs are black spruce, the trees white spruce.

IV. The Vertical Tree-line.

The vertical tree-line in the area is very indefinite, due to the modest heights of the mountains. Almost on the top of Irony Mountain were small bushes of black and white spruce. Fig. 7 shows that the low bushes of black and white spruces on alpine heaths sometimes occur together on the same habitat and attain a very similar appearance. The vertical line of tree-species in the area is therefore about 3000 feet, but tree-sized individuals and forest patches occur at about 2500 feet above sea level. (The vertical tree-line is of course markedly lower on the coastal mountains in Labrador; about 900 feet on the Mealy Mts., compare KINDLE 1924.)

Here on the mountain plateaux the same phenomen is observable as on the small islands in James Bay, i.e. white spruce attains tree-size in more exposed habitats than black spruce. The remarkable »semitundra»-formations on the slopes of Irony Mountain (see Fig. 6) are, thus, formed by dominating alpine heaths with scattered tree-sized white spruce and low black spruce bushes. White spruce bushes reach (if the summit of Irony Mountain is about 3000 feet above the sea-level) about 2970 feet and black spruce bushes about 2950 feet. These spruce bushes, 1—1½ feet high, are not fertile and there are very few of them on the summit. The annual shoots of these »alpine» spruce bushes are only about 1 inch on white spruce and about ½—1 inches on black spruce; the needles are about 0.4—0.7 cm long on both species in these exposed habitats. (Spruce reaches about the same height above sea

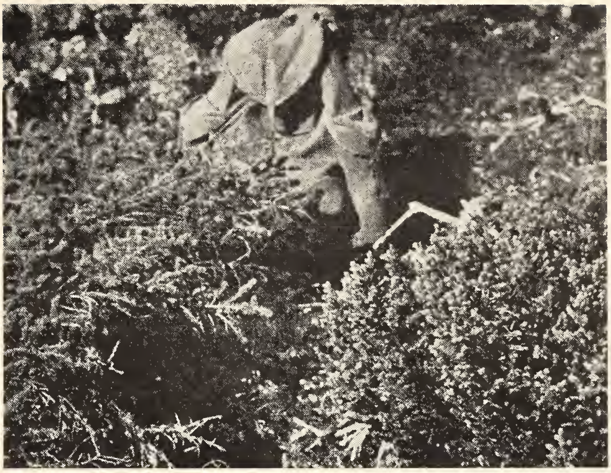


Fig. 7. Near the tree-line stunted white spruce (left) and black spruce (right) often look alike. Irony Mountain, S slope.

level on the Goodwood Mts.; one of highest-placed white spruces was about 45 feet in height and 16—17 inches in diameter.) Both tamarack and alder reach about 2600—2700 feet above the sea-level. Tree-sized white spruce (9—10 feet) reaches about 2500 feet. Scattered reproduction of slow growing seedlings (when one foot high sometimes 25—30 years old) could be found, mostly white spruce.

The »semitundra»-formation can be compared roughly with the northern subalpine region in Northern Europe, where 6—9 feet high *Betula tortuosa* occurs scattered on open heaths. I have seen no open »semitundra»-formation of this kind with low scattered spruces in other parts of Labrador, except for small patches on islands in James Bay. The »semitundra» plateaus, with scattered low white spruce trees and low black spruce thickets growing long distances apart cover large areas between Burnt Creek and Goodwood. From the distance the terrain takes on the appearance of a semi-desert. When growing as low creeping bush, black spruce sometimes shows a centrifugal growth; it forms a ring (the individual »bush» reaching about 10—15 m in diameter) of spruce-branches on the ground, a growth-pattern well known also from other tree-lines in the world. However, I never on these mountains saw a spruce carpet 2—4 inches high of the kind occuring on Pottles Hill, on the mainland Atlantic coast of Labrador (H 1939), where *Picea mariana* cfr. *f. empetroides* occurs above the tree-line. The black spruce bushes on the higher mountain plateaus in this Knob Lake-Goodwood area are more like

Picea mariana f. semiprostrata as described by MARIE-VICTORIN et ROUSSEAU 1940. The mountain slopes in the Knob Lake area are not windy enough to form real spruce carpets and thickets.

Higher up on the slopes the percentage of »dried» trees seems to be greater. Here the twisted deformed habitus of the trees is the same as is found on all exposed habitats. The root system is very superficial, owing to the small amount of till on many habitats, compare Fig. 8 of the root system of a tamarack at the tree-line near Burnt Creek. Some of the low creeping black spruces which do not reach the snow cover surface are over 250 years old and their trunks no more than 4—6 inches in diameter.

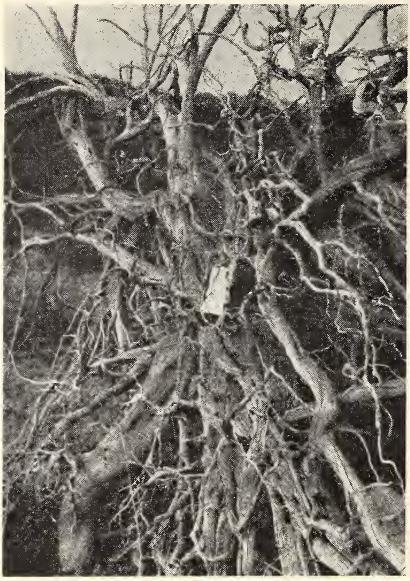


Fig. 8. The root system of a tamarack on a mountain slope near Burnt Creek.

In a few ponds above the forest-line old trunks could be seen, probably remnants of forest fires; these were places with no trees or very few stunted trees on the shores of the ponds or on the slopes above them (see Fig. 9). It

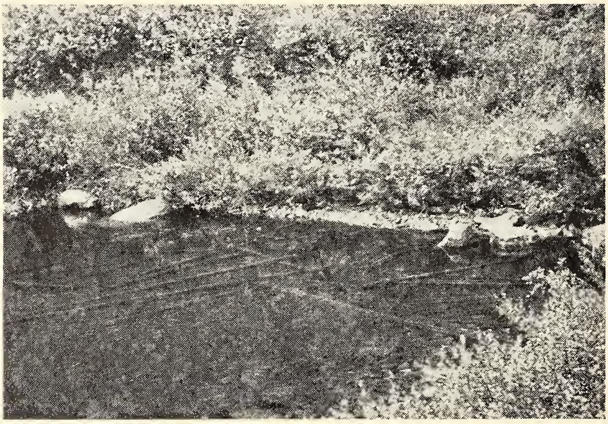


Fig. 9. Fallen trunks on the bottom of an alpine pond show that this area near Burnt Creek was once forested.

is difficult to state if we here have the same »retreat» of the forest-line as in northern Scandinavia (compare Enquist 1933). Higher up on the slopes a forest fire is usually devastating, completely precluding reproduction; the scanty forest is replaced by an alpine heath. In some exceptional areas there was good reproduction (see below p. 40) on such slopes.

The alder belt (so characteristic of the coastal mountains of Labrador, H 1939), is not well developed on the mountains in the interior. However, on mountains facing the Howell River valley, dense alder scrub occurs on slopes above the spruce forest proper. Juniper also occurs occasionally in this semitundra formation. On the slopes above the more or less continuous spruce forest small birch bushes are sometimes, but not very often, found (see above p. 12).

V. Notes on the Sample Plots.

In the following analyses of forest habitats, size and frequency notes are visual estimates only. The size of each sample plot is about 4 square metres. The frequency of the vascular plant species on the plots is indicated by the following simple scale: 3 = abundant (»dominant»), 2 = common, 1 = scattered, and the symbol »+» indicates occasional (one or two individuals only). This simple method has been used by the author earlier in his field work and is adequate for a preliminary survey. The vegetation of the sample plot is noted in Table I for localities 1—22. Notes on the approximate size of the trees on an area of about 100 square meters (about one-fortieth of an acre) around the sample plot are added to give an idea of the forest type. Reproduction in the sample plots was carefully noted. In most cases seedlings were collected for microscopical age determination.

The determination of the common »taiga»-plants in Table I was made by the author in the field; the rare and critical species were determined by A. E. Porsild, Chief Botanist of the National Museum of Canada (see H 1951a). For the assistance received I am very grateful. Notes on cryptogams on the sample plots were included (see below p. 24).

Sample plots 1—8 (representing lichen woodlands) are described in Acta Geographica 12. I shall therefore omit their general description in this paper. Sample plots 9—22 have been previously described in the National Museum of Canada Bull. 123 (H 1951a). However, some details have been added here, particularly re the age of the trees, and some cryptogam collections have been determined since then. Sample plots 9—22 are therefore described below.

Abbreviations: wspr = white spruce, bspr = black spruce, bfir = balsam fir. The expression »30 × 6, age 90» means a tree, 30 feet high and 6 inches in diameter about 4 feet above the ground (d.b.h.); according to increment borings the tree in question is 90 years at d.b.h., unless expressly stated »age 90 at the ground». The expression »12 × 16y» means a seedling 12 inches high and 16 years old according to microscopical determination.

The increment measurements were made by Mr. FRITZ BERGMAN in Helsingfors, Dept. of Forestry, using a special microscope (constructed by the Swedish expert Dr. BO EKLUND.) The microscopical determination of the age of the seedlings was made by the author (double checking). However, owing to the depressed growth on many localities, the age determinations are approximate only.

Sample plots 1—8.

Sample plot 1—8 = 9—16 in H 1951b, p. 17—18. Sample plot 1 in Table I = No. 6 in H 1951a. Sample plots 2—5 are respectively Nos. 2—5 and sample plot 6 = No. 1 in H 1951a.

Sample plots 9—22.

9. ½ mile NW of John Lake. A gentle slope about 150 feet above lake level, protected from a large fire in the surroundings 15—20 years ago. Good bspr pulpwood-sized forest of feather moss type on iron formation (wspr in the neighbourhood). 14 trees 9—36 feet high on 1/40 acre. Trees, all bspr, measured: 36 × 12, age 128 at the ground, 36 × 7, age 93; 36 × 7, age 101, 122 at the ground; 33 × 6, age 97; 18 × 4, age 55. The trees have no ground branches; in a few cases they have vegetative shoots. Rich cone production 1947. At least 2/3 of the trees have grown from seedlings. Reproduction poor because of thick moss cover; 1 bspr seedling, 15 × 25y.

10. Lake Gillard. A moderately dry spruce feather moss forest, about 30 feet above lake level, on the E shore of the lake. Good, but not dense stand of bspr and wspr of uneven age. On about 1/40 acre 12 wspr, 15—48 feet high and 6 bspr 9—45 feet. Trees measured: wspr 45 × 8, age 124; 45 × 8, age 111; 45 × 8, age 116, at the ground about 125; 48 × 9, age 129; 24 × 4, age 132 at the ground; 24 × 4, age 133; bspr 45 × 8, age 97; 42 × 10, age 105. The trees well-grown, with few cones; only one of the bspr with a vegetative shoot. The humus layer is about 6 inches deep. Reproduction poor because of the thick moss cover: wspr 18 × 35y, 24 × 44y, 20 × 47y, 24 × 55y, 18 × 60y, no bspr seedlings and one tamarack seedling (nearest tamarack 120 feet from the sample plot).

11. Lake Gillard. In a small valley, near E shore of the lake, about 15 feet above lake level. Wspr, (bspr)-bunchberry forest of pulpwood size, the trees are younger than on sample plot 10. On about 1/20 acre 14 wspr 9—36 feet high, one bspr candelabrum tree with 5 stems, 9—27 feet high, and 1 bspr 36 × 10. Fairly good cone production. Trees measured: wspr 30 × 6, age 70; 34 × 8, age 68; 30 × 7, age 80 at the ground; 21 × 4, age 64, and one depressed wspr, 9 × 2, age 79 at the ground; bspr 36 × 10, age 69. Reproduction poor, 2 bspr seedlings: 26 × 63y, 24 × 25y, with well developed adventitious roots; such seedlings develop later into candelabrum trees.

12. W-slope of Howells River valley between Lake Stakit and the mountains W of Lake Wishart. Mossy mountain forest of tall old wspr (includ. bspr) not devastated by the big fires in these regions 15—20 years ago. On 1/40 acre 4 wspr 42—57 feet high and 3 bspr 36—48 feet. Trees measured: wspr 57 × 12, age 179; 54 × 18, age 191; 42 × 8, age 152; bspr 48 × 7, age 64. The big old wspr thus form here the older stage; the bspr are partly deformed and partly extremely well-grown trees. A typical old virgin forest. Reproduction poor, only 1 tamarack seedling, 9 × 14y (the nearest tamarack 450 feet from the sample plot) and some vegetative shoots of bspr. The trees have no ground-branches, they have grown in a dense dwarf birch thicket.

13. Burnt Creek, 1 mile NW from the camp. Gentle slope with dolomite blocks on iron formation. Wspr forest with dense undergrowth. The trees are slightly deformed, mostly with two stems, 6 wspr on 1/40 acre, 22—48 feet high, no cones, good radial growth. The alder thicket reaches 9—12 feet and the glandular dwarf birch 4—6 feet; the snow cover is probably 4—5 feet deep. One willow (*Salix* cfr. *planifolia*) of almost tree-size, 12 feet. Trees measured: wspr 48 × 14, age 132; 27 × 8½, age 80 at the ground; 22 × 4, age 62 at the ground; 24 × 9, age 63. No reproduction, because of the dense ground cover.

14. Burnt Creek, about 1 mile W of the base camp. Wspr growing in a low-lying wet area along a dry brook between stony spruce lichen heaths in the upper part of the forest zone. Glacial till of shale and dolomite origin. On 1/40 acre: 4 wspr slightly rotten in the centre, and 2 bspr. Trees measured: wspr 48 × 19, age 282; 45 × 13, age 214; 24 × 5, age 68 at the ground; bspr 27 × 7, age 143 at the ground. Reproduction poor because of dense undergrowth: wspr 8 × 11y, with adventituous roots, an uncommon feature in wspr. One vegetative shoot of bspr.

15. Lake Gillard. Patches of rich wspr-bfir forest along the E shore of the lake, 3—6 feet above lake level. The stand is uneven, with 6 wspr (one 57 × 38, double stems) 24 × 57 feet high, 5 bfir 18—39 feet, one bspr 27 feet. Trees measured: wspr 45 × 9, age 97; 42 × 14, age 154; bfir 18 × 5, age 54 at the ground; bspr 27 × 8, age 96. Bfir with vegetative shoots. One wspr, 57 × 20, was about 300 years old, rotten in the centre. Reproduction poor, 1 wspr, 1 bspr and 1 bfir seedling only (not measured.)

16. About 1.5 miles south of the trail between *Knob Lake* and *John Lake*, on a gentle SE-slope. A wspr forest rich in herbaceous species and one of the best forest patches noted in the area. Trees on about 1/40 acre: 9 wspr 15—51 feet and 3 bspr 15—27 feet. Trees measured: wspr 51 × 28, age 158; 48 × 24, age 162; 36 × 8, age 78; 30 × 5, age 70; bspr. 27 × 5, age 112 at the ground. Two patches of dense scrub on the sample plot formed by vegetative reproduction; one, formed by bspr, measured 8 by 9 metres; the other, formed by bfir, measured 12 by 18 metres. A nearby wspr measured 60 feet in height. Reproduction poor because of the dense ground cover: bspr 12 × 24y, bfir 12 × 17—18y, 2 tamarack, 8 × 12y and 12 × 14y, both with adventitious roots.

17. Snelgrove Lake, 60—70 miles SE of Knob Lake. Old »rich» wspr forest on the lake shore 7 feet above lake level, on a very gentle slope facing SE. Probably dolomite and shales in the bedrock. Trees on about 1/40 acre: wspr 57 × 8, 54 × 9, 54 × 8, 54 × 9, 51× 9, 48 × 8, 42 × 8, 33 × 7, 24 × 4. The trees were about 150 years old and formed a better stand than any to be seen on the watershed area proper at Knob Lake. The trees are branchless up to 15—18 feet. The flora in the surroundings is luxuriant. No reproduction because of too dense ground cover.

18. Lake Gillard. About 300 feet above lake level. One of the scattered patches of big wspr in the area in the lake valley. The stand is surrounded by bspr lichen heaths. Trees on about 1/20 acre: 3 wspr 33—57 feet high, 8 bspr, 24—45 feet and one dead bspr. The wspr well-grown. 3 of the bspr with marked double-stem, frequently found in the area; some trees with branches down to the ground. One candelabrum bspr with 4 stems, the other bspr grown from seedlings. Trees measured: wspr 57×22, age 178; 54×16, age 112; 33×8, age 105; bspr 30×8, age 105; 24×7, age 103 at the ground. Reproduction poor: wspr 8×23y and 16×44y.

19. 3 miles E of Knob Lake, on shale formation. A rich, low-lying wet area of tamarack between spruce-lichen heaths. The sample plots have a more or less pronounced calciphilous flora, although small local areas around decaying tree stumps are acidic and support »trivial» plants, see p. 24. There are several acres of this type of »forest» in the vicinity. Trees on about 1/40 acre: 15 tamaracks, 3—25 feet, the crowns of 50—60 per cent of the tamaracks are half-dead. Also ten smaller wspr, about 4×2 in average, the largest 10×2 only. Trees measured: tamarack, 18×3, age 45 at the ground; 25×5, age 90; wspr 6×1, age 39 at the ground. Tamaracks have no vegetative shoots in this locality. Reproduction good: 36 tamarack seedlings (5—13 years old, see Diagram 12), 1 wspr, 8×13y, 2 bspr seedlings about 15 years old.

20. Lake Gillard. A wet area about 150 feet above lake level in the valley SE of the lake. A few acres with scattered bfir intermingled with bspr and tamarack; among them numerous decaying stumps and fallen trees. Bfir shows strong vegetative propagation. Trees on 1/20 acre: bfir, 30 × 6, with 4 vegetative shoots (1 foot high), 24 × 5 with 8 vegetative shoots (6 inches to 2 feet), 24 × 5 with 3 vegetative shoots (1 foot), 24 × 4 with 10 vegetative shoots (1 foot), 18 × 4 with about 50 vegetative shoots (1 foot), 21 × 4, 21 × 4, 15 × 3, 9 × 2; the last three of these bfirs had produced a total of 20 vegetative shoots about 2 feet high. One bfir stump alone had 50 vegetative shoots. This sample plot has a total of nine bfir trees over 9 feet high and about 150 vegetative shoots (6 inches to 3 feet high). 17 bspr, 6—39 feet high, on the sample plot; these originate in part from vegetative shoots, as can be seen from the bent trunks just on the surface of the ground. 3 tamaracks on the plot, 15×24 feet. Trees measured: bspr 30×6, age 81; 18×4, age 145 at the ground; bfir 30×6, age 82; 24×5, tamarack 24×4, age 56; 21×4, age 74 at the ground. In addition to the strong vegetative propagation of the bfir, reproduction by seedlings occurs on the plot: 18 tamarack seedlings, 13—25 years old; 10 bspr seedlings, 12—29 years old and 2 bfir seedlings. 6—11 years old. See Diagrams 12 and 15.

21. Lake Gillard. Near the lake shore about 75 feet above lake level, bspr and tamarack equally dominant on a swampy area several acres wide.

Trees on 1/20 acre: 8 bspr, 4—30 feet high, 6 tamaracks, 15—27 feet high, some deformed, also 5 dead bspr and 2 dead tamaracks. Trees measured: bspr 42×7, age 199; 22×4, age 83; 3.5×1, age at least 17. Reproduction: 19 bspr seedlings (5—24 years, see Diagram 15), 16 tamarack seedlings (12—26 years; see Diagram 12), nearly every one of the 35 seedlings with adventituous roots (compare p. 38).

22. 1 mile E of Knob Lake, small forest of old bspr »sticks» on iron formation (shales in the neighbourhood). Snow cover probably 2½ feet. Trees on 1/40 acre: 10 bspr. 6—18 feet high 1 tamarack 14 feet, all covered with black Alectoria cfr. jubata lichens. Trees measured: bspr 18×5, age 241; 15×3, age 145 at the ground; tamarack 14×2½, age 83 at the ground. Reproduction: poor, 2 bspr and 2 tamarack seedlings (all probably vegetative shoots).

VI. The Forest Vegetation.

Table I comprises vascular plants included in the notes of the sample plots.

Apart from these 55 species and the bush species mentioned on p. 12 f. the following 29 vascular plants occur in the forests in the area: *Cystopteris montana, Dryopteris linnaeana, D. phegopteris, D. spinulosa, Calamagrostis canadensis, C. inexpansa, Schizachne purpurascens, Poa nemoralis, Carex disperma, C. brunnescens, Salix pellita, Arenaria macrophylla, Actaea rubra, Corydalis sempervirens, Ribes glandulosum, Fragaria virginiana, Potentilla palustris, Viola labradorica,* (*Heracleum lanatum*), *Pyrola minor, Pyrola secunda, Galium triflorum, Lonicera villosa, Aster puniceus, Achillea nigrescens, Petasites sagittatus, Senecio pauperculus, Hieracium groenlandicum, Taraxacum lapponicum.* The species mentioned in Table I are the most important, however, and typical of the forests (except *Epilobium Hornemannii*). The above-mentioned additions to the forest flora are found mainly in balsam poplar groves and in rich, well-drained spots in the forest on the mountain slopes.

The forest vegetation tends to be poorer in vascular species towards the north, which is natural. Another common and typical feature is that forest plants, which farther south are restricted to certain habitats, in the subarctic forests are more widespread. This appears from Table I. Note the wide range of forest types and habitats of Labrador tea (*Ledum groenlandicum*), crowberry (*Empetrum hermaphroditum*), dwarf birch (*Betula glandulosa*) and mountain cranberry (*Vaccinium Vitis-Idaea*), for instance, in the Knob Lake area. These plants occur in the southern part of the taiga on bogs, but also in the north on dry lichen heaths and in moist forests. This variability of the site-requirements of certain common plants is also well-known from northern Europe.

Inside every forest type and sample plot there is a great variability in the microclimate. This does not of course cover the whole amplitude from

Table I. The ground vegetation (vascular plants only) on sample plots 1—22.

Sample plot	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Betula glandulosa	1	1	1	1	—	2	2	2	1	1	2	1	2	2	1	×	×	2	—	×	3	—
Ledum groenlandicum	×	1	×	×	1	1	2	—	×	1	2	1	2	—	—	—	×	—	×	2	1	1
Vaccinium cespitosum	1	1	—	—	—	—	×	2	×	—	1	1	×	—	—	1	×	×	—	×	—	—
Empetrum hermaphroditum[1]	—	1	×	2	2	1	1	2	2	1	1	1	—	×	—	1	1	2	×	2	×	—
Lycopodium annotinum[2]	×	×	—	×	—	×	×	×	—	1	×	×	1	—	1	—	×	—	—	—	—	—
Vaccinium uliginosum	—	1	1	1	×	1	—	×	×	1	×	2	—	—	—	—	1	×	×	2	—	1
Solidago multiradiata	×	—	—	—	—	×	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Vaccinium Vitis-Idaea[3]	—	×	—	×	×	×	×	×	×	×	1	×	×	—	—	×	×	—	—	×	—	—
Vaccinium angustifolium	—	—	1	—	1	1	×	—	—	2	—	—	—	—	—	—	×	—	—	—	—	—
Comandra livida	—	—	—	—	1	—	—	—	×	—	—	1	—	—	—	—	—	—	—	—	—	—
Lycopodium sabinaefolium[4]	—	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lycopodium complanatum	—	—	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Salix cfr. Bebbiana	—	—	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Deschampsia flexuosa	—	—	—	—	—	—	×	×	—	—	×	×	—	—	×	—	×	—	—	—	—	—
Epilobium angustifolium	—	—	—	—	—	—	×	—	—	—	—	—	—	—	—	×	×	×	—	—	×	—
Cornus canadensis	—	—	—	—	—	—	×	×	×	×	2	3	×	×	1	2	2	1	—	×	—	—
Petasites palmatus	—	—	—	—	—	—	—	—	—	—	×	×	×	×	1	1	—	×	—	×	—	—
Solidago macrophylla[5]	—	—	—	—	—	—	—	—	—	—	×	1	1	—	2	1	×	×	×	—	—	—
Coptis groenlandica	—	—	—	—	—	—	—	—	—	—	—	×	—	—	×	—	×	×	—	—	—	×
Alnus crispa	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—
Salix cfr planifolia[6]	—	—	—	—	—	—	—	—	—	—	—	—	×	2	×	—	—	2	—	1	—	—
Linnæa borealis	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	×	1	1	—	—	×	—
Mitella nuda	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	1	1	—	—	—
Trientalis borealis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—
Viburnum edule	—	—	—	—	—	—	—	—	—	—	—	—	×	—	—	1	—	—	—	—	—	—

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Rubus acaulis	—	—	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—	×	—	—	—	—
Rubus strigosus	—	—	—	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—	—	—	—	—
Luzula parviflora	—	—	—	—	—	—	—	—	—	—	—	—	—	×	—	—	—	×	1	—	—	—
Geum rivale	—	—	—	—	—	—	—	—	—	—	—	—	—	×	—	—	—	—	1	—	—	—
Epilobium Hornemanni	—	—	—	—	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—	—	—	—
Stellaria calycantha	—	—	—	—	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—	—	—	—
Pyrola uniflora	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×	×	×	—	—	—	—	—
Calamagrostis Langsdorfii	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	×	×	—	×	—
Streptopus amplexifolius	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×	×	—	—	—	—	—	—
Salix cfr. cordifolia[7]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×	—	—	—	2	—	—	—
Rubus pubescens	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×	—	—	—	1	—	—	—
Ribes triste	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—	—
Equisetum silvaticum[8]	—	—	—	—	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—	1	—	—
Equisetum cfr. palustre	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×	1	×	—	—	—
Carex cfr rostrata	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—
Petasites vitifolius	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×	—	—	—
Rubus chamaemorus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	2	2
Oxycoccus microcarpus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×	×	×	×
Selaginella selaginoides	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×	—	—	—
Chiogenes hispidula	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×	×	×
Listera cordata	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×	—	—
Kalmia polifolia	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×	—	×
Chamaedaphne calyculata	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	2
Smilacina trifolia	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×	×
Carex trisperma	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	×
Carex paupercula	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
Carex canescens[9]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
Salix pedicellaris[10]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×	—
Myrica gale	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×
Ranunculus lapponicus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×
Number of species	5	7	5	6	7	10	11	8	8	8	11	14	13	11	14	14	17	16	15	15	15	12

dry lichen covered soil to wet Sphagnum, but it is noticeable for instance in a lichen forest too. Under the tree crowns in a »pure» spruce lichen forest can be found, as pointed out in H 1950, i.a. the dwarf shrubs crowberry and mountain cranberry and feather moss species. The nutrition conditions and the light conditions immediately under the crown and in the openings are different. Re the behaviour of *Hylocomium splendens*, compare TAMM 1950. It is of interest to note that also in a feather moss forest crowberry and mountain cranberry keep more or less under the tree crowns.

In the tamarack swamp forests in the Knob Lake area the plant cover is mostly composed of calcicoles, i.e. lime-preferring plants, but non-calcicole elements also occur, the reason being simply the occurrence of old decaying stumps (with low pH) which attract not only seedlings but also »trivial» elements (oxylophytes, sensu ST. JOHN 1922) like Labrador tea, cranberry, crowberry etc.

All such features in the behaviour of the common forest plants are of interest and must be noted before we fully understand their real significance as site-indicators.

Remarks to Table I.

1. According to North American taxonomists = *Empetrum nigrum* (var. *hermaphroditum*), 2. incl. var. *pungens*, 3. var. *minus*, 4. var. *sitchense*, 5. var. *thyrsoidea*, 6. very uncertain field determinations, 7. On sample plot 19 probably *Salix arctica*. 8. var. *pauciramosum*. 9. var. *subloliacea*. 10. var. *hypoglauca*. — Names mostly according to *Gray's Manual*, 8th edition (1950). A few minor corrections have been made in Table I, compared with Table I in H 1951a.

VII. Cryptogams in the Forest.

Cryptogams play a greater part in the northern taiga forests than in the southern spruce region. It is, however, erroneous to assume that this means that the amount of organic matter formed on a lichen heath or a feather moss cover is very small compared with the quantity of wood formed on the same area. ROMELL has stated (1939, p. 381) that »very extensive tracts of northern spruce forests must produce considerably more moss than wood».

Forests with a predominantly lichen or moss cover are extremely common in the northern taiga. The »*Aralia*-type» and similar types, in which the mosses and lichens play a minor part, belong to the southern spruce region, and only on very suitable or specific habitats (balsam poplar groves, for instance) are herbs and grasses found in absolute dominance. The dwarf shrub and bunchberry forests in the taiga always show many cryptogams.

Table II is an attempt to illustrate the gradual change in the cryptogam-cover from dry to moist or wet forest habitats. It can be noted that among the feather moss species *Pleurozium Schreberi* is more common than *Hylocomium splendens; Ptilium* (*Hypnum*) *crista castrensis* is more or less restricted to richer feather moss forests. The different *Sphagnum*-species have different ecological requirements. *Sphagnum Warnstorfianum,* for instance, prefers the lime-influenced fen habitats and *S. fuscum* the poorer bog forests. They also form different habitats for tree seedlings. Another typical feature of the cryptogam flora of northern forests is the abundance of *Dicranum fuscescens,* which has the widest amplitude of the species in Table II.

The dominant lichen in the lichen woodlands is, as clearly appears from Table II, *Cladina alpestris.* (The occurrence of a *Dicranum*-cover under the *Cladina* cover on some lichen woodlands in the area is noted in H 1951b.) The other lichens are of minor importance as site-indicators. Re the epiphyte lichens (i.e. lichens on twigs and trunks), we can note that the common black beard lichen (*Alectoria jubata* coll.) gives the old spruce trees in the area a characteristic feature. The dense growth of beard lichen is, however, not always limited to old trees, neither is it a disease. The *Hepaticae* finally, are of minor importance from a forest-ecological point of view.

The dominance of cryptogams means that also the site-requirements of these small plants are important for a true understanding of the succession of forest types in the area and of the quality of the site. The interest of forest botanists in northern Europe has turned in recent times to the ecology of the cryptogams on the forest floor (compare Tamm 1950 re feather mosses, Sarvas 1952 etc.)

Because our knowledge or forest cryptogams in the northern taiga is very limited (and because a forester slightly familiar with cryptogams gets a better idea of the site from a presentation of the cryptogam cover than from many soil-chemical descriptions) notes were made and samples collected of the cryptogam flora. Table II gives a summary of the notes of most important cryptogam species. The estimations of their abundance is, of course, very approximate only.

The following list of cryptogams (not included in Table II, but collected on the sample plots) is given here as a floristic appendix to the vegetation notes:

Lichens on the ground: *Cladonia pleurota* (on sample plot 6), *Cetraria nivalis* (7), *Peltigera aphthosa* (4), *P. aphthosa ssp. leucophlebia* (5), *P. scabrosa* (11), *Toninia cumulata* (6), *Icmadophila aeruginosa* (11). Mosses (*Musci*)*: Dicranum majus* (6), *D. angustum* (14), *D. Bergeri* (p. 42). *D. scoparium* (p. 42), *Drepanocladus uncinatus* (14, 15), *D. fluitans* (20), *Polytrichum piliferum* (7, 8), *P. juniperinum* (7, 8), *P. strictum* (p. 42), *Calliergon stramineum* (14), *C. sarmentosum* (14),

Table II. Cryptogam cover on sample plots 1—22.

Sample plot	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Lichens:																						
Cladina alpestris	3	3	3	3	3	3	3	2	×	—	—	—	—	—	—	—	—	—	—	—	—	—
Cladina mitis	—	×	—	×	×	1	×	—	×	—	—	—	—	—	—	—	—	—	—	×	—	—
Cladina rangiferina	—	×	×	×	×	×	1	×	×	—	×	—	—	—	—	—	1	—	—	×	—	—
Stereocaulon ssp.	—	×	×	—	—	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cetraria islandica	—	—	—	×	×	—	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cladonia coccifera coll.	—	—	—	×	—	×	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cladonia gracilis[1]	—	—	—	—	×	×	×	×	—	×	×	—	×	—	—	—	—	—	—	×	—	—
Opisteria arctica	—	—	—	—	×	—	—	×	—	×	×	×	—	—	—	—	×	—	—	—	—	—
Alectoria jubata coll.	—	×	—	×	×	—	×	×	—	×	—	—	—	—	×	—	—	—	×	×	—	—
Mosses:																						
Pleurozium Schreberi	—	—	×	—	×	—	×	2	3	2	2	2	3	1	1	2	3	2	—	×	—	—
Hylocomium splendens	—	—	—	—	—	×	×	—	—	—	2	—	—	×	1	2	—	2	×	×	—	—
Dicranum fuscescens	—	×	×	×	×	×	×	×	×	1	×	×	×	—	—	—	—	—	—	—	×	—
Ptilium crista castrensis	—	—	—	—	—	—	—	—	×	1	×	1	1	1	—	1	1	1	—	—	—	—
Polytrichum commune	—	—	—	—	—	—	—	—	—	—	×	×	—	—	—	—	—	—	—	—	—	—
Tomenthypnum nitens	—	—	—	—	—	—	—	—	—	—	—	—	—	×	—	—	—	—	×	—	—	×
Aulacomnium palustre	—	—	—	—	—	—	—	—	—	—	—	—	—	×	—	—	—	×	1	1	1	—
Sphagnum Warnstorfianum	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	×	2	—	—	×
Sphagnum ssp. (except Sph. Warnstorfianum)[2]	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	3	3	3

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[1] On sample plot 5 var.chordalis, on sample plot 11 ssp.elongata.

[2] See the specification on p. 27 below

Mnium rugicum (14), *Pohlia nutans* (16, 21, p. 42), *Paludella squarrosa* (19), *Campylium stellatum* (22), *Philonotis* sp. (14). Peat moss (*Sphagnum*): *Sphagnum parvifolium* (15, 20—22), *S. Girgensohnii* (15, 20), *S. Russowii* (= *robustum*) (12, 20, 21), *S. magellanicum* (21), *S. nemoreum* (21), *S. fuscum* (22). Liwerworts (*Hepaticae*): *Ptilidium ciliare* (4, 10), *Lophozia ventricosa* (1), *L. Wenzelii* var. *grandiretis* (20), *Cephalozia media* (20), *Barbilophozia Hatcheri* (6, 10, 11, 16), *B. barbata* (16), *B. lycopodioides* (16), *Orthocaulis Kunzeanus* (7, 19), *O. quadrilobus* (18), *O. attenuatus* (1, 7, 20), *Tritomaria quinquedentata* (14, 18, 19), *Blepharostoma trichophyllum* (18), *Mylia anomala* var. *purpurascens* (20). Epiphyte lichens: *Cetraria ciliaris* (5, 10, 19, 20), *Alectoria lanestris* (15, 19, 20), *A. nidulifera* (10, 15, 19), *A. sarmentosa* (15), *Parmelia sulcata* (10, 19), *P. obscurata* (4, 5, 10, 20), *P. physodes* (5, 10, 15), *P. laevigata* (10), *Parmeliopsis pallescens* (7, 10, 19, 20), *P. ambigua* (15, 19, 20), *Ochrolechia androgyna* (10), *Pertusaria multipunctata* (5), *P. pustulata* (15), *Mycoblastus sanguinarius* (10, 15), *Mycocalicium savonicum* (5, 10), *Clopophylla*[1] *Fendleri* (10), *C. scutata* (10). Most of these are very common plants. Compared with the Hudson Bay coast annotations (H 1950), the absence of *Ramalina Roesleri* and *Evernia mesomorpha*, common on the spruces on the east coast of Hudson Bay, is noteworthy. Note also the absence of *Usnea*-species. Re forest epiphyte lichens, compare KUJALA 1926 and AHLNER 1948.

The determination of the cryptogams has been made by the Finnish specialists Dr. VELI RÄSÄNEN († 1953, lichens), Dr. ERNST HÄYRÉN (lichens), Dr. HANS BUCH (Hepaticae) and Dr. RISTO TUOMIKOSKI (Musci); I express my sincere gratitude to my collegues. I regret that the collecting of *Fungi* was beyond my competence.

The forest vegetation thus comprises about 85 vascular plant species and at least 75 different species of lichens and mosses.

A comparison between the forest vegetation of the North Shore or the Peribonka forests etc. and the Knob Lake forests reveals a good correlation with the changes found on moving from the forests in southern Finland into northern Finland. There is a marked increase in the role of at least the following plants in the forest vegetation: *Empetrum hermaphroditum*, *Vaccinium Vitis-Idaea*, *V. uliginosum*, *Ledum groenlandicum*, *Betula glandulosa*, *Cladina alpestris*, *Dicranum fuscescens*, *Polytrichum*. The following important forests plants decrease in abundance: *Linnæa borealis*, *Cornus canadensis*, *Trientalis borealis*, *Pyrola* ssp. Common forest plants that are entirely absent in the Knob Lake area are: *Aralia nudicaulis*, *Oxalis montana*, *Maianthemum canadensis*[2], *Pteridium aquilinum*, *Dicranum rugosum* (= *D. undulatum*). The dominance of the sedimentary bedrock rather than the northern situation is responsible for the marked decrease in the frequency of *Vaccinium angustifolium* and *V. myrtilloides* and for the absence of *Arctostaphylos uva-ursi*. The good correlation between these notes from eastern Canada and KUJALA's description (1936) of the changes in forest vegetation from southern to northern Finland must be noted.

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[1] *Cetraria*. [2] Found at Northwest River 1937. I. H.

VIII. Forest Types.

The above material is not sufficient for an analysis of the forest- or site-types in the area. Indeed it would be very difficult to attempt such an analysis in any case. The area is situated between taiga proper and forest-tundra, between mountains and lowlands of varying topography. In such regions the forests tend to be less homogenous, with many types represented in a comparatively small area. However, certain forest-types are common: spruce lichen forests, spruce lichen dwarf shrub forests and tamarack swamps. Fairly common also are rich white spruce forests (i.e. forests with good timber-sized white spruce, rich in herbs), particularly in the lowlands on sedimentary bedrock.

Table I is arranged to give an approximate idea of the development of the forest vegetation from sample plots with dry and poor vegetation to the plots rich in herbs, ending with sample plots on bogs and swamps. The sample plots, in the author's opinion, belong to the following tentative main forest types:

Spruce (tamarack)-lichen forests: sample plots 1—5(6).
Spruce dwarf shrub lichen forests: sample plots (6) 7—8.
Spruce feather moss forests: sample plots 9—10.
Spruce bunchberry forests: sample plots 11—12.
(Intermediate sample plots 13—14, 20).
Rich white spruce forests: sample plots 15—18.
Tamarack swamp or fen[1] forests: sample plot 19.
Black spruce bog forests: sample plots 21—22.

H. 1949 describes the main forest types (tentative) in the Labrador taiga and compares them with forest types in northern Russia, Scandinavia and other parts of Canada.

The lichen woodlands (= spruce lichen forests and spruce dwarf shrub lichen forests) and their ecology are dealt with in H 1951b. Their flora of vascular plants is, however, noted in Table I; Fig. 22 in H 1950 shows a typical »map» of a sample plot from a lichen forest. Compared with the Great Whale

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[1] By »fen» the author means a mire (peatland) fairly rich in herb and grass species. »Bog» is a mire with poor vegetation and low pH values.

River region (H 1950) the lichen woodlands appear less »pure» in the Knob Lake area.

The feather moss forests do not seem to be so well developed here as in the granite-gneiss lowlands. The feather moss forest has only a few vascular plants or dwarf shrubs, remnants of an earlier richer flora of vascular plants. A young feather moss forest is seldom found: the trees are generally at least 100 years old, often 150; note that the age in many cases is as high as 25 years when the tree is 1.3 meter high. Reproduction capacity is very poor.

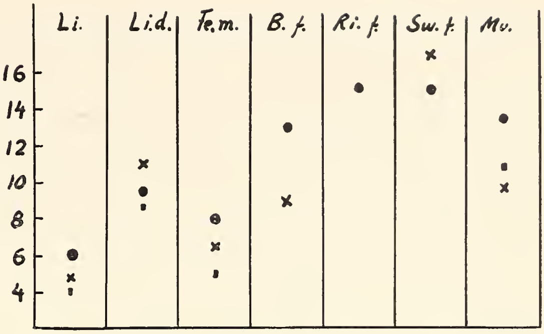


Fig. 10. The approximate relation between forest type and number of species. Black dots = Knob Lake, x = Great Whale River (H 1950) and the small dots = Fort George (H 1950), according to the vascular plant flora on the sample plots described above and in H 1950.

The white spruce forests rich in herbs are common in the lowlands and are typical of more or less calcareous areas with good drainage. They are frequently encountered S of James Bay too, i.e. forests with timber-sized white spruce and herbs such as *Mitella nuda, Cornus canadensis, Coptis groenlandica, Trientalis borealis, Pyrola uniflora* and other species, which in the northern forests represent »rich elements» in the vegetation. The number of species is greater in these forests than in others with the occasional exception of open tamarack swamps on calcareous soil (compare Fig. 10). Reproduction is poor because of the dense undergrowth of mosses and herbs.

Fens and tamarack swamps are typical of the sedimentary bedrock area in Labrador. White spruce swamps of the kind described from Sucker Creek on the east coast of Hudson Bay (H 1950) were not noted. In such localities tamarack is the dominating tree species, but it never, as is well known, occurs in closed stands. Reproduction in such »forests» is good and the flora rich. The pH-values of old decaying stumps in the swamps are lower than those of the surroundings; tree stumps and their surroundings are also slightly drier. For these reasons the old stumps attract vascular plants of another character, i.e. *Empetrum, Vaccinium* ssp., *Ledum, Rubus chamaemorus* etc., than the surrounding calciphile swamp plants.

The black spruce muskeg and the black spruce bog forest, the »forest of sticks», belong to poorer soils with stagnant water. The muskegs and the bog forests are not of the same areal importance here as in other parts of the taiga.

The tree species, like the plant species (see above), react in different ways in southern and northern forests. The author has earlier pointed out the fact that black spruce, the typical muskeg tree in southern Quebec and northern USA, grows well on very dry habitats in the Labrador Peninsula. White spruce and tamarack (sample plot 1 above) also are found on dry sites in the Knob Lake area. One explanation is that the seemingly dry heaths in the north are not dry in the same sense as the dry heaths in the south. SARVAS reached this conclusion in a recent (1952) paper on pine lichen forests in northern Finland. I have no measurements to indicate this statistically. A moisture index map (compare SANDERSON's map of Canada 1950) does not sufficiently explain the distribution of the lichen woodlands in Canada. For instance, the Knob Lake area is »perhumid», and northwestern Canada is »dry subhumid» and »moist subhumid». Lichen woodlands occur all over the northern hemisphere. (see H 1951b).

If we use the expression »dry» (and the author has not seen any other expression used) for the moisture conditions of an open lichen forest, we get the following picture, Fig. 11, of the range of distribution of forest trees on the physiographic sites of the Knob Lake area compared with the Middle Ottawa-Georgian Bay region (HILLS 1952). HILLS has recently formed an original classification and evaluation of the concept site in forestry. I am not familiar enough with his terminology; particularly the conception »eco-climate» is difficult. However, Diagram 11 shows — superficially — the change in site requirements of tree-species using HILLS' diagram (l.c., p. 38) for Ontario as a model for the comparison. The comparison, tentative only, shows clearly the great difference in the reaction of the trees to the physiographic sites in the two regions. Thus, site description and forest-type classifications have to be made for restricted local areas. This is, of course, well known to the forest scientists; I have only indicated one more reason for care in forest site classifications. To what extent is it possible in this case to operate with *ecotypes* (sensu TURESSON) *of tree-species?* Is, for instance, the candelabrum-form of black spruce an ecotype?

The author's notes on the vegetation of the sample plots are visual estimates only. But using the same method from place to place and from year to year gives a material which permits the comparison of notes from different localities. Diagram 10 thus illustrates the variation in the number of species on sample plots from different forest-types. The fact that the number of vascular plants is low in sample plots from feather moss forests, in spite of its sufficient moisture, clearly indicates that there must be some particular

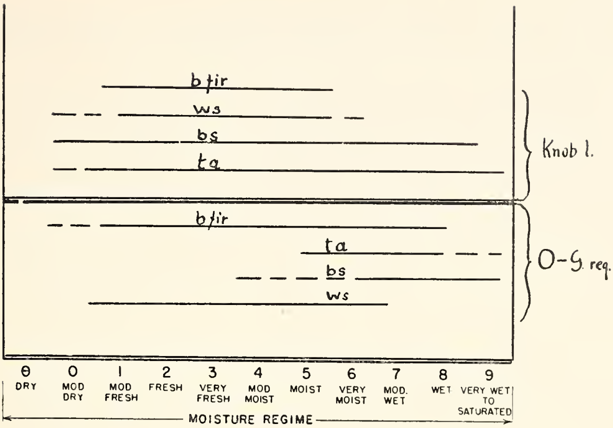


Fig. 11. The approximate moisture requirements of tree species in the Knob Lake area compared with HILLS' notes (1952) from the Ottawa-Georgian region.

reason for this fact: e.g. the ageing forest turns into a climax stand with few phanerogam-species more or less regardless of the soil conditions. The diagram compares sample plots from Fort George forests (compare H 1950) with Great Whale River and Knob Lake sample plots.

A virgin forest in the Knob Lake area is never fully closed; it has empty spaces and the trees stay in a »ring». The reason is primarily the fact that such a virgin forest always represents a very uneven stand, often a climax stand as well. When, in such a forest, with generally no reproduction capacity at all, old trees die, they leave an empty space which is invaded very slowly only by new seedlings or vegetative shoots. This is because the ground vegetation cover is very dense (compare p. 19). Only if a fire has completely destroyed an earlier forest does a more closed stand appear.

Regarding the succession of the forest types in the area, we certainly know too little to allow conclusions of practical importance. The impression gained by the author, however, is that an open lichen forest slowly changes into a lichen dwarf shrub forest. The bunchberry forests, not very typical in the area, and the rich white spruce forests gradually move into feather moss dominated forests. There is constant dynamic development in a forest; it is never fully stable.

Diagram 28 illustrates that the trees grow faster on rich white spruce forests than in feather moss forests; growth is slowest in the lichen forests. Compare also the diagrams of the seedlings, though they are very approximative only.

IX. The Generative Reproduction of the Forests.

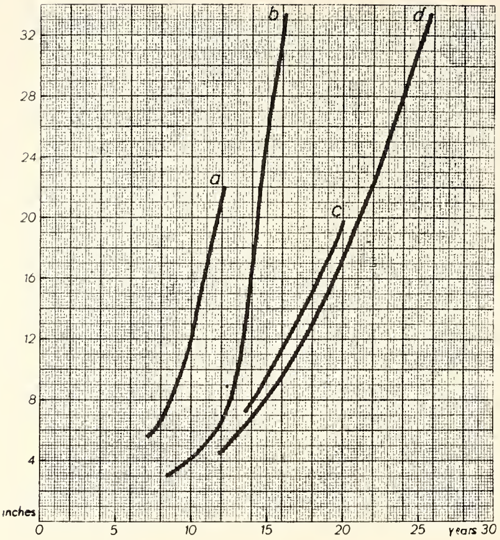


Fig. 12. Growth in height and age of tamarack seedlings, a = sample plot 19, b = see p. 42, c = 20, d = 21.

Notes on the reproductive capacity of these northern Canadian forests are very scarce in the literature. The description above of the sample plots gives the number of seedlings on each. As in other parts of the northernmost coniferous forests, the quantity of seedlings is satisfactory on the lichen heaths, but growth is severely retarded by a number of unfavourable factors, such as poor soil, snow-damage, and exposure to strong winds on the ridges and terraces where the spruce-lichen forest is common.

In the spruce-lichen forests, the commonest forest type in the area, spruce seeds germinate readily, especially in small crevices in the lichen; and, wherever larger open patches occur in the lichen cover, spruce seedlings are rarely absent because they are able here to reach the mineral soil (compare 1951 b). The same is true also of the more thoroughly investigated pine-lichen heaths in northern Scandinavia. Spruce seedlings, however, grow very slowly and sometimes reach only 1 to 2 feet in height in 50 to 60 years; this is an extremely slow growth, even slower than the growth of pine seedlings in similar habitats in Lapland (see H1948). Diagrams 12 to 15

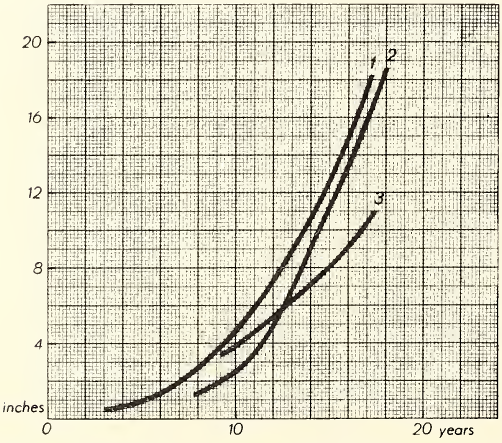


Fig. 13. Growth in height and age of white spruce seedlings: 1 = sample plot 7, 2, see p. 40, 3, see p. 42. Note the slow growth.

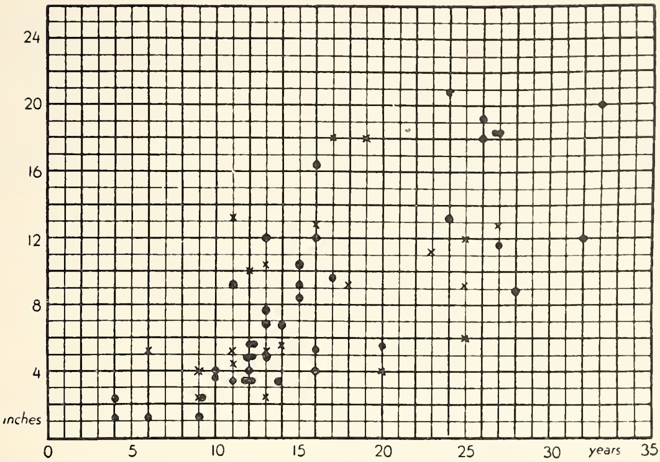


Fig. 14. Growth in height and age of white and black spruce seedlings from a spruce lichen forest near Lake Gillard, near sample plot 2. ● = white spruce, x = black spruce seedlings. Note that no difference in the earlier development of the two spruce species can be found on this locality.

show the relation between the height of the seedlings and their age. The seedlings start their definitive growth in height very slowly, in their 10—20th year. The percentage of damaged seedlings on lichen heaths is usually great. Many of the spruce seedlings on lichen heaths are badly developed from the very beginning, with two or several stems, i.e. seedlings which probably will subsequently grow into candelabrum-trees, compare Fig. 16. The great night radiation on open heaths probably kills some seedlings; so do the great temperature differences (compare H 1951b).

The feather moss forest type seems to represent a climax forest with reproduction poor or entirely lacking owing

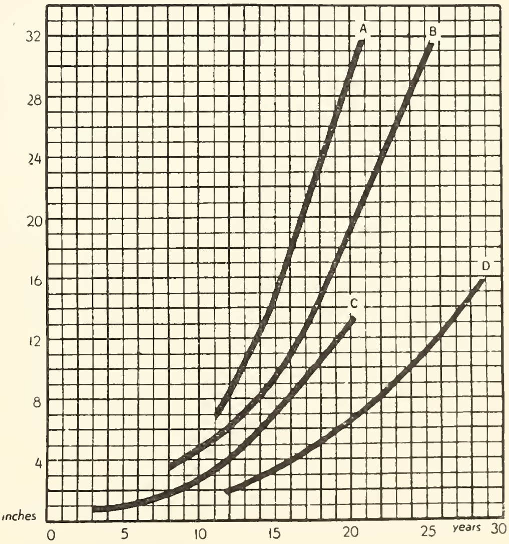


Fig. 15. Growth in height and age of black spruce seedlings: A, see p. 42, B = sample plot 21, C = 6, D = 20. Note the slow growth.

to the dense moss cover. In such a moss cover the spruce seeds may germinate but the roots do not reach the mineral soil through the thick moss and humus layer. The same is true in forest types with a dense herbaceous ground cover and in old groves. (In this watershed area there has never been any cutting; the only factors disturbing vegetation cycles have been fires, storm damage, and natural decay in a virgin forest.)

Reproduction seems to be best in rather moist habitats, where not only tamarack but also black spruce shows satisfactory seedling development. Black spruce seedlings grow extraordinarily well in burned swamp forests, sometimes showing well-grown terminal glaucous twigs like white spruce seedlings. Balsam fir, near its northern limit here, reproduces poorly in the area.

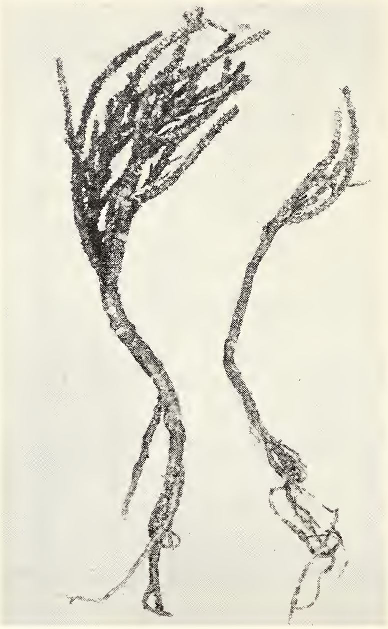


Fig. 16. Two depressed white spruce seedlings from a spruce lichen forest near Lake Gillard. Heights resp. 11 and 9 cm, age impossible to determine with certainty, probably 15—20 years old.

About 330 seedlings were collected during my short stay at Knob Lake. The maximum height of the seedlings in Table III was 2 feet. Their age has been determined microscopically. Owing to the slow growth especially on the lichen heaths, the radial growth in some years is only two to three cell layers. Occasionally the radial growth is eccentric to such a degree that age determination is impossible. The age determinations have been summarized in Table III.

No vegetative shoots have been included in Table III; at least this has been checked a carefully as possible.

A further source of error in the age determination of these seedlings is the ability of black spruce and tamarack seedlings to form adventitious roots, see p. 36. This is particularly common on wet habitats where the apical growth of *Sphagnum* is rapid.

A superficial check only of the age of such seedlings, i.e. confined to the surface of the moss cover, will lead to erroneous age determinations.

Thus there are many potential sources of error in Table III. Accepting this, the table suggests that spruce and tamarack produce mature seeds nearly every year, even though, quantitatively, the seed production varies from year to year, as do the climatic conditions for successful germination.

Table III. Microscopical age determinations of 249 spruce and tamarack seedlings in the Knob Lake area.

Age class: (0 = 1948)	White spruce	Black spruce	Tamarack
1	—	—	—
2	—	—	—
3	1	—	—
4	5	1	—
5	—	—	1
6	1	2	—
7	—	1	—
8	10	4	2
9	11	7	2
10	2	1	1
11	4	6	1
12	19	21	4
13	12	9	2
14	13	3	8
15	11	7	4
16	8	1	1
17	2	6	2
18	—	1	—
19	—	4	1
20	2	3	1
21	—	3	—
22	—	1	2
23	2	3	—
24	2	4	1
25	—	4	—
26	4	1	1
27	3	1	—
28	1	—	—
29	—	—	—
30	—	1	—
31	—	—	—
32	1	1	—
33	1	1	—
34	—	—	—
35	1	1	1
	116	*98*	*35*

Table III shows that age class »12» (O = 1948) is prominent in spruce, owing to the fact that 1934 probably was an unusually warm summer in this area. Age class »9» is likewise well represented, because 1938 was probably a good seed year for this species. There is no correlation between my notes on the age of seedlings from Hudson Bay (H 1950) and the present figures. A much bigger material is needed for such correlations.

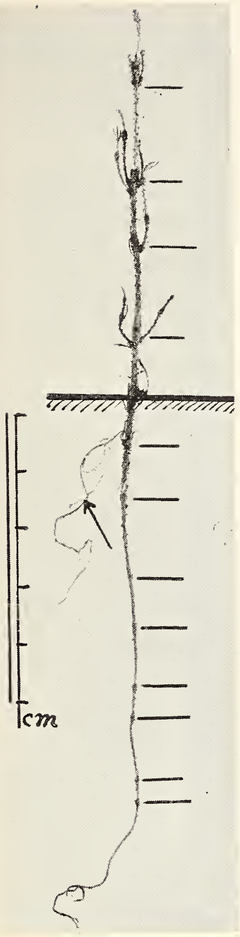
It can be assumed that spruce forest at its northern or vertical limit has about the same general ecology as the better investigated Scotch pine forest at its northern limit in Europe.

Investigations show that Scotch pine seed years do not occur every year; certain temperature requirements must be fulfilled before the seed matures in the cones. There are intervals of many years between good seed years in the north. The temperature requirements for the production of mature black spruce or white spruce seeds at their northern limits are still unknown. From the fact that the circumboreal tree-line coincides fairly well with the July 10°C isotherm one may assume that the American northern spruce species follow, at least in part, the same ecological laws as Scotch pine at its northern limit. Regarding the interval between good seed years, see Renvall 1912, Hagem 1917, Heikinheimo 1920, Eide 1932 and H 1948.

A very approximate casual estimation of the intensity of cone production 1947 and 1948 in the Knob Lake area (1-year cones), scale 0—3, showed: white spruce 1947 3, 1948 0; black spruce 1947 2, 1948 1; tamarack 1947 3, 1948 0; fir 1947 0—1, 1948 0; alder 1947 3, 1948 2. Thus, 1947 was a good cone year in the area. There was a marked difference between the cone-production in the Seven Islands and in the Knob Lake area. In Seven Islands (using the same casual estimation) white spruce cone production in 1947 and 1948 was 3, black spruce 1948 2, balsam fir 2, alder 3. Also on the Hudson Bay coast white spruce cone production was good in 1947.

X. Adventitious Roots.

The ability to form adventitious roots is widespread among the tree-species in the taiga. As pointed out above, it is found in black spruce, tamarack and balsam fir and also in alder and other deciduous species. Only with white spruce are adventitious roots seldom found. Particularly they are developed by black spruce growing on peat moss (compare Le Barron 1945). I have seen black spruce seedlings, 1 foot high, which in their 18th year still form adventitious roots in order to escape becoming submerged in the »rising» *Sphagnum* cover. These features in the development of



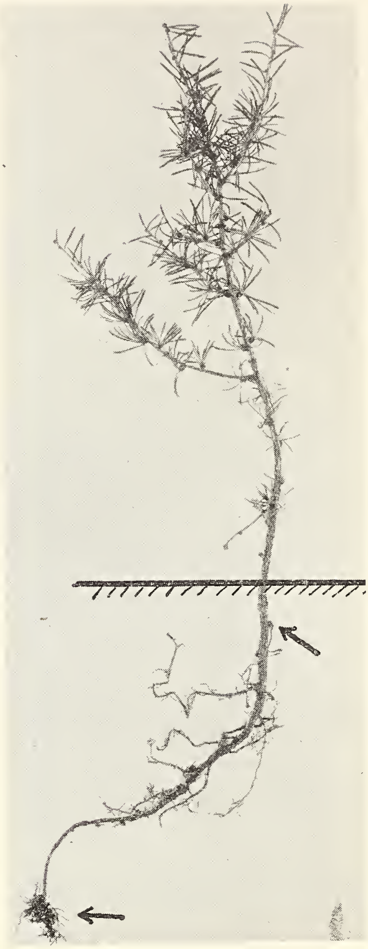


Fig. 17. Black spruce seedling from peat moss with adventitious roots. About 13 years old.

Fig. 18. Tamarack seedling, from a swamp. The lower arrow points to the primary roots, the other arrow to an adventitious root.

black spruce and tamarack on peat soil are still more extremely developed in the peat bog areas in the stagnant water divide areas, but are also clearly seen in the Knob Lake area. The adventitious roots are formed in the nodes between the annual shoots by black spruce and in the dwarf shoots by tamarack, as is shown by Figures 17 and 18. Diagram 19 illustrates the development of a black spruce seedling growing in *Sphagnum*. It is a general observation that spruce seedlings on muskeg habitats are found on tussocks of compact

Table IV. Adventitious roots on sample plot 21.

BLACK SPRUCE				TAMARACK			
height of seedling above surface	age	adventitious roots by age	height of seedling below surface	height of seedling above surface	age of seedling	adventitious roots by age	height of seedling below surface
11 cm	14	9	9	28 cm	15	5	10 cm
22	14	6—7	13	26	15	7—8	12
17	15	8	15	16	12	4—5	6
23	15	7	11	18	12	5—6	12
20	16—17	9	14	—	15	7—8	—
32	14	10—11	10	7	10—11	4	9
21	15	9—10	12	13	14	8	10
27	16—17	9—10	13	22	14	3	—
19	15	10—11	13	—	—	—	—
11	9	3—4	—	—	—	—	—
12	11—12	7	13	—	—	—	—
10	12	5	—	—	—	—	—
27	15	5—6	11	—	—	—	—

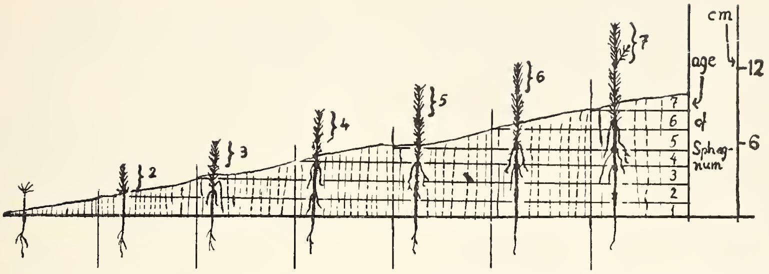


Fig. 19. A rough diagram of a black spruce seedling growing in peat moss, compare p. 37.

Sphagnum species (*S. fuscum*, etc.) but not on the wetter areas between. And if *Sphagnum* and feather moss, for instance, occur side by side, which often is the case on many muskeg localities, the seedlings are found in *Sphagnum* but not on the feather moss. The *Sphagnum* cover grows annually 1—2 cm (slowgrowing species) and up to 5—6 cm where faster-growing *Sphagna* are concerned, as pointed out by my colleague Dr. R. TUOMIKOSKI. This means that there is a continuous battle between the growing spruce seedling and rising moss cover, as illustrated by Diagram 19. The moss cover, which probably starts its growth earlier in the spring, overshadows the buds of the young spruce seedling and thus promotes the development of adventitious roots. The physiology of these processes is unclear, at least to the author, but the result seems to be clear. LE BARRON, who studied adventitious roots of black spruce in Minnesota believes that the eventual replacement of the old roots by new ones is »due to the better aeration near the surface of the soil» (1945, p. 311). The freezing and re-freezing of the peat moss cover might also be a factor worth considering. Table IV illustrates the occurrence of adventitious roots from seedlings on sample plot 21. Only one of the white spruce seedling on sample plot 21 showed adventitious roots in the second year. At sample plot 20 the same features were noted; adventitious roots were found up to the 13th year with black spruce and up to the 12th year with tamarack. See also SAARINEN 1933 and ARNBORG 1943.

As Fig. 17 shows, the formation of adventitious roots means a decreased cambial activity of the internode below the new roots. The primary root collar slowly decays as the tree grows older. Age measurements at the ground of black spruce stems growing in muskegs are thus extremely uncertain.

Vegetative shoots are common in black spruce and balsam fir, where these form a depressed undergrowth in old forests. With balsam fir vegetative propagation is probably far more important than generative propagation in northern localities. Black spruce and tamarack in the Knob Lake area »behave» in about the same way as in the taiga region in general.

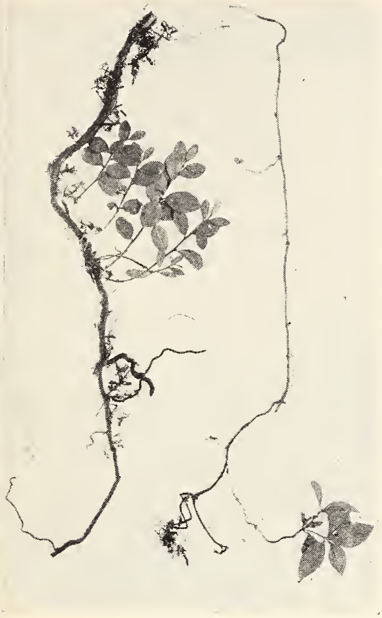
A very great percentage of the trees, particularly on muskeg areas, are developed from earlier vegetative shoots, cf. PLACE 1950. Old trees developed from vegetative shoots have a bent trunk and a very eccentric radial growth.

The vegetative shoots are characterised by a very depressed growth; such shoots and trees are always older than the diameter suggests. For instance, 9 foot high vegetative shoots of black spruce on muskegs are sometimes nearly 100 years old. With balsam fir too the vegetative shoots usually have a poorer cambial activity than main trunks developed from seedlings.

XI. Reproduction after Forest Fires.

In these northern parts of the taiga reproduction after fires is in some ways a more difficult problem, in some ways a much easier problem than farther south. It is a dangerous problem too, when a forest fire occurs on mountain slopes, because regeneration is usually poor on such exposed localities. The fire destroys the organic soil layer and exposes it to both erosion and solifluction. Particularly on the Atlantic coast there are earlier forest slopes now more or less treeless with an alpine heath instead of a forest (H 1939). In the Knob Lake area too there is evidence of the same disastrous effect on many slopes. But when a good seed year happens to occur at the right time and when at least some trees are left undestroyed by the fire, good regeneration can occur, as is shown by the following example from a »subalpine» heath near a small brook, about 1 mile NW of Burnt Creek base camp, partly covered with glandular dwarf birch.

The original forest was largely destroyed by a fire about 18—20 years ago. There are no trees on the sample plot itself, but a few white spruce were noted in the vicinity. The soil is partly open mineral soil. The winter snow cover is probably about 1—2 feet deep. The vegetation estimate, using the same scale as in the sample plots above, is: *Betula glandulosa* 2 (about 1—2 high), *Vaccinium Vitis idaea* 2, *Lycopodium annotinum* (only under dwarf birch) 1, *Empetrum hermaphroditum* +, *Juncus confusa* +, and the following cryptogams: *Cladina alpestris*, *Cladonia* ssp., *Cetraria* ssp., *Alectoria* ssp., and the usual mosses on such burns, *Polytrichum piliferum* and *P. juniperinum* on open mineral soil. In the dwarf birch scrub on the sample plot *Sphagnum parvifolium*, *S. Russowii*, *Pleurozium Schreberi*, *Polytrichum commune*, *P. strictum* were noted. Reproduction: on the 1/40 acre plot were 46 white spruce seedlings 8 to 17 years old, some of them much deformed by wind and snow (see Diagram 13). The seeds came from a white spruce tree (No. 48 in Table VIII; very good cone production at least in 1947) growing on the sample plot.



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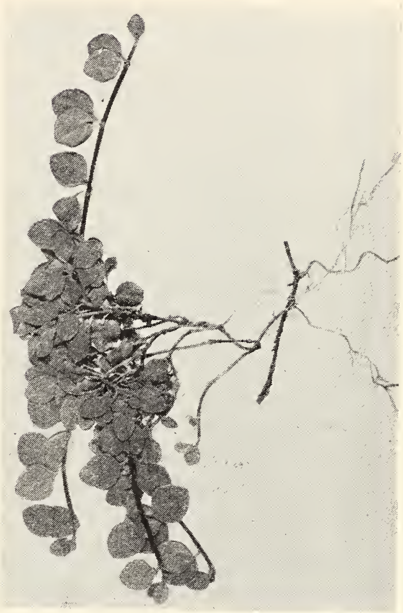

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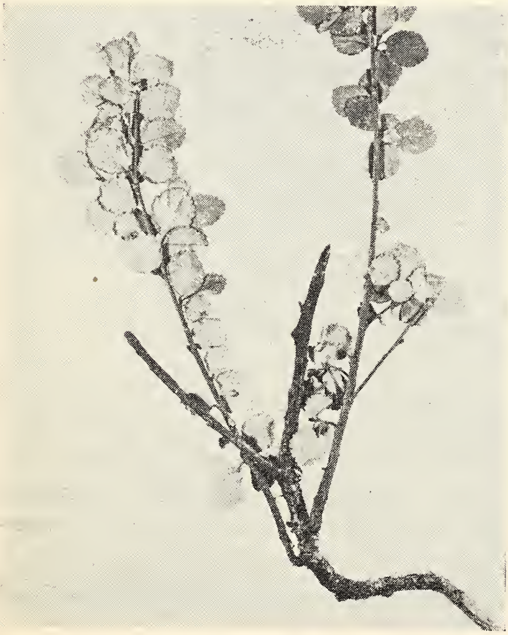

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Fig. 20—22. Plants on a burn one summer after the fire. 20 = Cornus canadensis and Vaccinium uliginosum, 21 = Linnaea borealis, 22 = new shoots on dwarf birch. Fig. 20—27 from the Knob Lake Area (1948). Photo: S. Holmström.

Another sample plot showing regeneration after a fire was situated in the upper part of the forest region, about 1.5 mile E of Knob Lake. The area, between a recent burn and a sheltered forest, was burned 23 years ago. Apparently some of the low trees escaped destruction by the fire. The sample plot was earlier probably a moist mixed forest with black and white spruce and scattered tamaracks, i.e. of the same kind as the forest near the burn. Trees on the sample plot: one 7 foot white spruce, 11 black spruce trees 4—14 feet high, and 4 larger dead trees. Of these the age of the white spruce at the ground was about 22 years. A 14 foot black spruce was at least 34 years old, showing good cone production, and another black spruce, 6 feet high, was about 21 years old (at the ground) and had its first cones in 1944. The seedlings are well developed, as can be seen from Diagram 15. Black spruce seedlings on slightly moist localities generally grow well after fire. On the 1/40 acre were collected 17 white spruce seedlings 10—23 years old, 17 black spruce seedlings 10—21 years old and 9 tamarack seedlings 8—15 years old. The ground vegetation was the following: *Vaccinium angustifolium* 2, *V. uliginosum* +, *V. cespitosum* 1, *Epilobium angustifolium* +, *Solidago macrophylla* var. *thyrsoidea* +, *Lonicera villosa* +, *Taraxacum* sp. +, Dominant *Pleurozium Schreberi*, incl. *Dicranum Bergeri*, *D. scoparium*, *Polytrichum strictum* (»tussocks» 4 inches deep), *Pohlia nutans*, *Aulacomnium palustre*, and scattered lichens (*Cladina* cfr. *mitis*, *Cladonia* ssp. *Stereocaulon* sp.).

Figures 20—22 show the reaction of following species one year after the fire: 20 = *Cornus canadensis* and *Vaccinium uliginosum*, 21 = *Linnæa borealis* var. *americana*, 22 = *Betula glandulosa*. Their strong capacity for vegetative propagation explains the longevity and fast re-growth of dwarf shrub species on the burned areas. It is particularly important to note that the northern forests have very few (see below) specific »fire plants», i.e. plants particularly favoured by burned areas, such as *Prunus pensylvanica* (not known[1] at all in the Knob Lake area) in the southern spruce region.

On the recent burns in the Knob Lake area the following plants were usually found in about the following composition on an earlier spruce lichen dwarf shrub forest: *Betula glandulosa* 1, *Vaccinium angustifolium* 1, *Deschampsia flexuosa* 1, *Epilobium angustifolium* +, *Corydalis sempervirens* +, *Ribes glandulosum* +, *Calamagrostis* cfr. *canadensis* +, *Comandra livida* +, *Cornus canadensis* +, *Vaccinium uliginosum* +, *Taraxacum* sp. + and *Cladina* and *Hylocomium* with new shoots. Of these plants *Epilobium*, *Ribes* (see Fig. 23), *Deschampsia*, *Taraxacum* and *Corydalis* were often obviously new intruders. *Epilobium* also easily propagates from old rhizoms. *Corydalis sempervirens* is the commonest annual plant on many first-year burns in the area,

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[1] Found at Northwest River 1937. I.H.

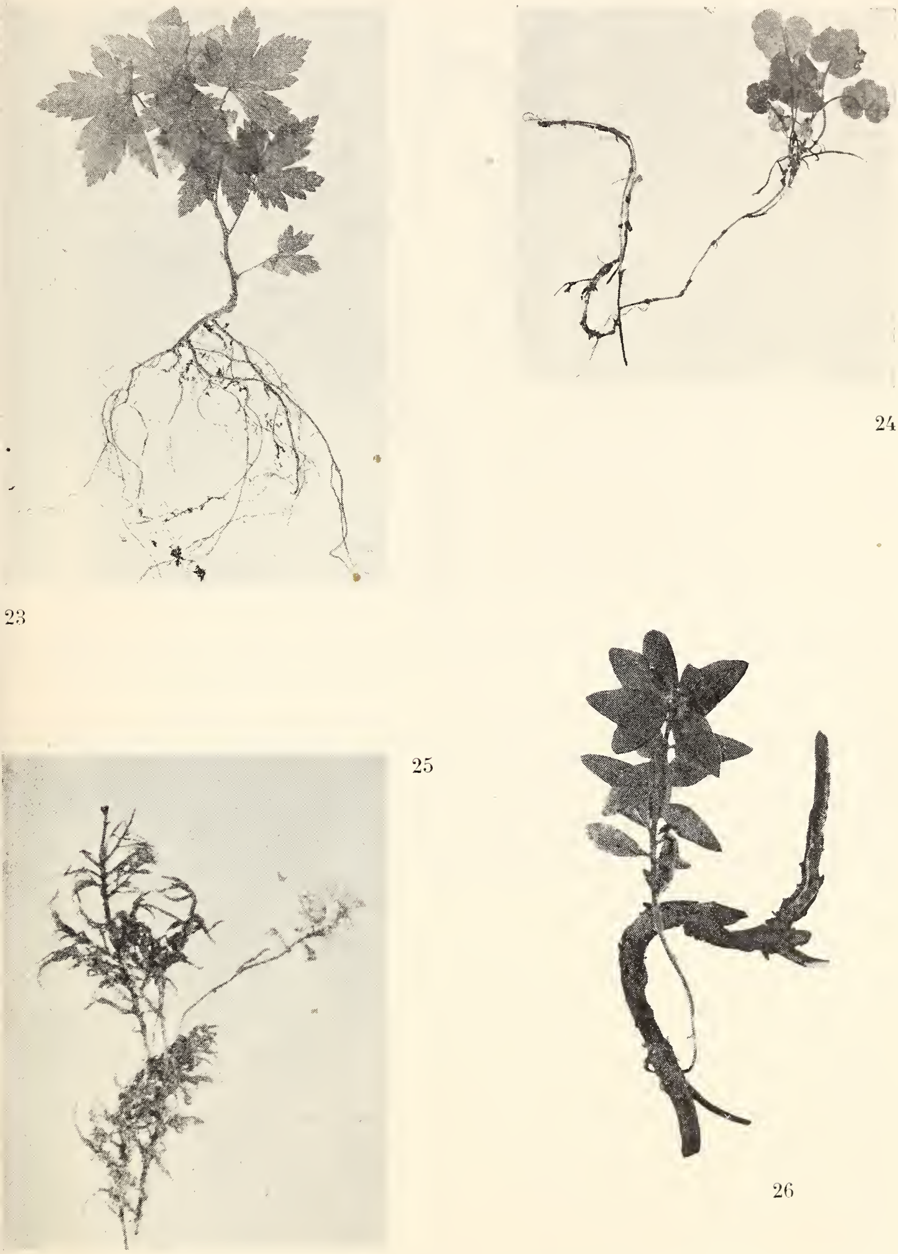

Fig. 23—26. Plants on a burn one summer after the fire. 23 = seedling of Ribes glandulosum, 24 = vegetative reproduction of Mitella nuda, 25 = new shoots formed on Hylocomium splendens, 26 = new shoot on Labrador tea.

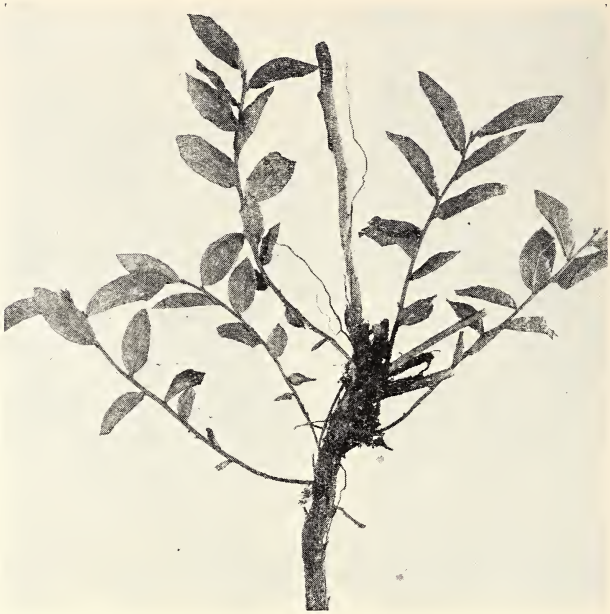

Fig. 27. New shoots (1948) on Vaccinium angustifolium after a fire in the autumn 1947.

even in the upper part of forested slopes. Labrador tea is quite an active plant on such areas in the first and second year. *Carex deflexa* occurs on such localities and blossoms with great intensity. *Deschampsia flexuosa* showed luxuriant growth, as did *Calamagrostis canadensis.* Species like *Rubus acaulis, Mitella nuda* (Fig. 24) and *Linnaea borealis* showed an active and much denser growth on burned habitats.

The moss and lichen cover is generally not completely destroyed by a fire. The fire can burn all the trees on the spot and yet the vegetation, incl. cryptogams, is able to recover. The *Cladina* species seem, but not always, to have the capacity to recover after fire with new »shoots», as described by Sarvas (1937). Note also Jalas' description of the regeneration of lichen heaths (1953). Figure 25 shows that *Hylocomium splendens* is able to reproduce vegetatively after a burn. A fire, however, destroys the vegetation at least superficially, and that decreases the battle for space on the forest floor. It also opens up new patches with mineral soil, where the seeds of trees and vascular plants germinate. A fire changes the temperature conditions of the soil and increases its mineral content. All these are usually factors favouring a new active vegetation.

When an old forest burns several major changes follow. The forest burns affect the trees and the vegetation differently according to the intensity of the fire. In every case the quality of the soil is changed because ash is added to the forest floor. Ash of wood has a rather high K_2O and CaO content, which fertilizes the ground. Wood ash is used as fertilizer on bog forests in northern Scandinavia and has resulted in a marked improvement (MALMSTRÖM 1948). Experiments made by ENEROTH show that seedlings grown in soil with ash of wood added show an increase in growth (1936). The author's field notes from forest burns in the Knob Lake area and from other areas in Labrador confirm this. But the wood is not burned completely during a forest fire. A forest fire is probably followed by nitrogen activitation on the forest floor at the same time, otherwise it is difficult to understand how after a burn the vascular plants behave more or less similarly to the reaction of forest vegetation to nitrate fertilization. Fig. 3 in H1951 b illustrates the look of a lichen forest after a burn one summer ago. Almost nothing shows signs of immediate recovery. The dwarf shrubs present show slow vegetative reproduction. In some places the very thin humus layer on such habitats is destroyed by the fire and this opens up the mineral soil for seedlings if seed trees can be found in the vicinity. If not, the area turns into a heath. On a feather moss forest the effect of a fire as of logging on the soil itself is mainly positive (compare also PARKER 1952), the thick humus layer is partly destroyed and receives an addition of wood ash and needle ash and of leaves of trees and plants. The fire does not reach very deep into the moss layer and most of the roots and rhizoms are thus undamaged, forming new and usually very vigorous vegetative shoots within the first year after the fire.

XII. Tree Growth.

The growth in height was studied only on seedlings, see p. 32 and Diagrams 12—15. The radial growth was studied more extensively, with the aid of a Swedish increment borer. Increment cores were taken on the south side at breast height of typical trees on the different sample plots. Cores were taken from about 130 trees; the microscopical age measurements are given on p. 46 ff. Cores were often taken also at ground level but at this level it is difficult to find the centre of the trunks.

The microscopical measurements of the annual radial growth were carefully made (unit 0.01 mm.). Only exact annual growth measurements give the true radial growth pattern of a tree. Such measurements also illustrate well the often neglected great variations in growth from year to year. The shrinkage of the cores due to their dried condition is 2—3 per cent only (Ilvessalo 1942). The diameter and height figures are visual field determinations only. Table V gives us radial growth series in 0.01 mm. units for black spruce from 5 sample plots and Table VI radial growth series for white spruce from 11 sample plots.

In spite of differences in moisture conditions and in spite of the fact that we are dealing with two different species, the annual variations in growth are very similar. Table VII gives two longer series, using older trees. It is natural that old trees react less readily to climatic variations from year to year. Thus, the growth variations in the 19th century are exaggerated in the tables. From a forestry point of view the exact measurement of the growth in radial thickness of trees growing on certain habitats are of greater interest than »smoothed values».

Table V. Black spruce growth series from Knob Lake (0.01 mm.).

Sample plot	5	6	7	9	10
Number of trees	2	2	2	3	2
1948	22	25	73	40	47
1947	19	26	56	40	45
1946	20	26	53	38	37
1945	16	25	63	33	38
1944	25	25	80	36	38
1943	18	27	86	40	43
1942	19	24	78	49	45
1941	22	27	90	56	42
1940	18	25	85	41	33
1939	16	26	96	46	43
1938	24	31	115	47	46
1937	28	35	127	55	50
1936	27	30	103	40	44
1935	23	31	98	43	55
1934	27	29	82	46	63
1933	29	31	49	43	44
1932	20	34	55	42	47
1931	22	38	54	46	60
1930	27	101	67	48	63
1929	20	36	47	44	39
1928	24	45	60	45	51
1927	19	44	53	45	47

Sample plot	5	6	7	9	10
Number of trees	2	2	2	3	2
1926	15	30	58	37	26
1925	16	44	49	49	42
1924	21	45	62	54	55
1923	17	40	57	43	42
1922	18	42	54	46	45
1921	18	40	54	48	57
1920	21	41	52	54	61
1919	20	41	69	59	62
1918	22	44	62	52	62
1917	25	52	63	59	55
1916	24	63	60	66	70
1915	24	60	57	70	77
1914	26	74	70	76	76
1913	23	71	61	72	80
1912	20	63	50	59	64
1911	15	77	70	70	72
1910	17	58	65	63	72
1909	18	52	67	74	68
1908	19	60	65	70	68
1907	18	55	77	69	72
1906	20	56	81	79	68
1905	18	47	85	72	61
1904	19	66	85	80	59
1903	19	51	85	82	72
1902	20	69	92	91	85
1901	18	69	90	83	86
1900	16	65	78	84	67
1899	17	75	97	95	73
1898	25	90	79	99	90
1897	25	80	88	129	101
1896	20	52	93	107	105
1895	22	58	102	132	112
1894	22	45	78	112	119
1893	26	38	83	114	107
1892	27	30	—	113	109
1891	30	51	—	150	110
1890	21	38	—	110	98
1889	25	61	—	110	65
1888	25	60	—	122	95
1887	25	64	—	120	94
1886	27	76	—	128	112
1885	27	68	—	115	123

Sample plot	5	6	7	9	10
Number of trees	2	2	2	3	2
1884	19	68	—	114	118
1883	22	74	—	131	116
1882	17	57	—	110	104
1881	24	67	—	132	129
1880	21	76	—	130	125
1879	22	—	—	99	130
1878	24	—	—	111	120
1877	20	—	—	104	116
1876	17	—	—	90	112
1875	17	—	—	107	95
1874	18	—	—	106	106
1873	18	—	—	106	106
1872	20	—	—	97	103
1871	20	—	—	110	96
1870	17	—	—	87	96
1869	21	—	—	85	101
1868	20	—	—	93	93
1867	20	—	—	87	93
1866	15	—	—	97	107
1865	19	—	—	96	106

Table VI. White spruce growth series (0.01 mm.).

Sample plot	3	4	7	8	10	11	12	14	15	16	18
Number of trees	3	3	2	5	4	3	3	2	2	4	2
1948	26	30	116	30	40	46	70	20	81	67	70
1947	31	30	123	36	35	51	61	14	62	66	71
1946	22	28	108	34	32	40	58	19	71	60	58
1945	19	26	106	28	38	46	57	16	67	50	68
1944	29	32	98	38	42	54	69	25	79	65	78
1943	32	27	112	34	40	61	63	20	81	67	82
1942	30	30	113	36	45	73	61	27	85	70	90
1941	27	29	133	37	39	58	61	22	72	65	95
1940	26	29	105	31	34	54	52	21	67	67	98
1939	33	36	107	32	40	57	56	22	81	88	99
1938	28	31	117	37	44	53	56	30	72	87	105

Sample plot	3	4	7	8	10	11	12	14	15	16	18
Number of trees	3	3	2	5	4	3	3	2	2	4	2
1937	36	41	101	51	58	64	72	35	63	98	98
1936	27	35	103	35	35	42	55	25	65	85	93
1935	31	40	108	38	37	56	63	26	78	99	95
1934	48	46	118	51	44	60	79	33	86	121	112
1933	33	36	104	47	34	50	65	26	82	89	88
1932	26	35	87	37	31	54	76	25	86	88	92
1931	33	35	84	40	40	51	78	27	80	137	109
1930	47	35	91	50	44	55	71	24	83	115	126
1929	39	31	69	33	32	45	59	19	68	81	88
1928	40	28	81	41	37	53	62	22	85	126	112
1927	39	29	81	49	41	68	68	23	76	99	110
1926	34	18	67	36	29	58	51	13	66	84	78
1925	33	23	70	44	30	55	54	23	80	89	101
1924	41	30	70	46	36	64	68	23	63	98	115
1923	31	23	65	47	40	67	57	18	60	77	92
1922	35	25	62	44	35	77	62	17	63	83	100
1921	36	27	71	39	39	78	62	26	79	91	100
1920	34	22	75	41	32	75	64	20	68	96	103
1918	43	30	76	53	49	120	90	31	74	106	126
1918	41	27	63	46	40	99	79	26	88	89	116
1917	39	25	68	51	42	111	91	31	95	107	122
1916	48	25	70	62	45	114	99	32	100	120	105
1915	46	27	57	55	42	111	96	29	78	111	96
1914	42	26	60	49	44	129	105	34	82	119	110
1913	37	24	57	44	41	126	107	36	88	120	97
1912	29	22	44	47	28	112	82	31	80	99	89
1911	41	30	71	60	38	120	100	44	101	131	125
1910	33	20	69	46	32	119	96	32	91	104	83
1909	33	30	58	40	34	127	92	37	82	121	107
1908	41	26	56	43	35	130	90	33	80	99	96
1907	40	29	60	39	39	155	93	38	80	123	131
1906	38	24	46	45	30	141	78	38	65	113	125
1905	32	23	52	37	29	125	78	41	78	118	122
1904	38	27	112	38	32	109	97	44	91	125	141
1903	51	34	109	35	37	105	101	50	75	119	144
1902	40	27	117	38	36	140	79	40	57	111	120
1901	41	23	118	39	31	114	92	47	73	102	117
1900	41	24	116	37	29	124	73	39	61	100	117
1899	42	25	102	32	31	123	77	40	61	103	122
1898	41	30	117	36	35	130	86	44	69	130	131
1897	66	45	158	53	60	196	98	54	82	141	136

Sample plot	3	4	7	8	10	11	12	14	15	16	18
Number of trees	3	3	2	5	4	3	3	2	2	4	2
1896	50	34	142	50	38	141	89	52	82	112	120
1895	64	43	158	59	49	199	117	64	103	143	140
1894	52	32	156	45	30	138	89	50	75	108	119
1893	54	31	128	48	44	191	91	50	102	111	129
1892	54	31	105	42	27	173	88	47	82	107	140
1891	65	28	120	49	37	175	111	67	87	139	174
1890	45	21	120	41	28	159	90	66	64	125	160
1889	39	29	123	48	28	165	95	70	71	126	145
1888	55	30	134	50	34	185	109	82	96	144	180
1887	59	35	154	45	36	—	89	68	87	149	165
1886	65	42	137	41	42	—	85	67	88	136	180
1885	58	32	127	41	44	—	85	80	72	123	171
1884	50	28	170	40	37	—	76	70	100	128	180
1883	59	32	—	48	40	—	81	69	88	136	169
1882	47	33	—	35	47	—	78	59	80	124^4	171
1881	82	40	—	47	44	—	90	74	142	148^2	165
1880	75	38	—	64	61	—	100	73	120	153	155
1879	65	26	—	55	47	—	95	54	128	123	151
1878	69	22	—	51	55	—	94	65	145	123	169
1877	54	20	—	38	42	—	74	64	136	113	145
1876	68	19	—	45	46	—	72	58	121	111	138
1875	76	25	—	50	52	—	88	74	123	134	156
1874	83	28	—	57	57	—	85	65	107	121	135
1873	81	29	—	56	53	—	94	62	121	134	141
1872	74	25	—	47	44	—	86	53	101	113	130
1871	56	20	—	36	35	—	68	47	96	109	118
1870	55	19	—	39	45	—	65	53	102	105	136
1869	47	20	—	35	44	—	75	54	98	120	130
1868	57	29	—	45	54	—	82	68	90	148	132
1867	66	25	—	36	48	—	65	62	96	134	126
1866	54	24	—	38	49	—	73	65	77	122	123
1865	53	25	—	41	48	—	61	57	77	129	115
1864	46	31	—	35	50	—	58	62	73	136	100
1863	54	34	—	34	77	—	63	63	83	135	118
1862	52	30	—	35	72	—	54	60	88	120	112
1861	59	35	—	38	80	—	46	58	102	113	102
1860	54	36	—	37	79	—	58	57	114	96	98
1859	53	25	—	34	80	—	54	45	135	122	96
1858	85	24	—	35	110	—	77	58	187	138	116
1857	48	20	—	21	70	—	50	63	135	138	111
1856	63	34	—	24	78	—	69	63	148	193	123

Sample plot	3	4	7	8	10	11	12	14	15	16	18
Number of trees	3	3	2	5	4	3	3	2	2	4	2
1855	71	32	—	34	83	—	71	47	107	138	90
1854	91	42	—	43	112	—	96	71	117	154	125
1853	97	41	—	48	90	—	77	63	—	107	111
1852	73	30	—	38	91	—	74	63	—	110	107
1851	82	42	—	34	121	—	68	85	—	155	128
1850	77	49	—	30	113	—	76	102	—	156	128
1849	79	51	—	35	112	—	62	93	—	153	113
1848	81	49	—	41	147	—	50	75	—	148	122
1847	73	52	—	47	119	—	60	75	—	166	131
1846	78	47	—	47	125	—	61	97	—	166	121
1845	83	46	—	48	114^{4}	—	61	69	—	159	137
1844	85	44	—	47	84^{2}	—	59	78	—	149	127
1843	91	46	—	45	100	—	65	68	—	123	122
1842	95	43	—	43	91	—	64	61	—	129	135
1841	92	40	—	30	85	—	72	82	—	141	126
1840	93	37	—	37^{5}	106	—	53^{3}	61	—	134	104
1839	103	45	—	42^{4}	94	—	69^{2}	86	—	178	129
1838	69	39	—	41	68	—	49	76	—	156	124
1837	71	42	—	38	95	—	49	53	—	—	—
1836	74	39	—	49	98	—	62	69	—	—	—
1835	73	37	—	44	78	—	54	73	—	—	—
1834	111	58	—	51	126	—	85	98	—	—	—
1833	98	56	—	59	—	—	71	91	—	—	—
1832	106	51	—	56	—	—	74	88	—	—	—
1831	97	52	—	48	—	—	74	89	—	—	—
1830	131	76	—	61	—	—	97	106	—	—	—
1829	127	64	—	60	—	—	78	104	—	—	—

Table VII. Radial growth series 1781—1948.

	Bspr.	Wspr.		Bspr.	Wspr.
1948	28	46	1941	26	47
1947	25	43	1940	22	43
1946	23	42	1939	26	51
1945	23	36	1938	28	51
1944	27	47	1937	32	58
1943	24	44	1936	27	46
1942	24	49	1935	25	52

	Bspr.	Wspr.		Bspr.	Wspr.
1934	30	65	1890	30	70
1933	31	50	1889	32	77
1932	27	53	1888	35	89
1931	31	63	1887	35	82
1930	37	62	1886	32	85
1929	31	44	1885	35	77
1928	34	53	1884	32	74
1927	30	55	1883	37	76
1926	26	40	1882	26	66
1925	31	49	1881	35	90
1924	32	56	1880	36	87
1923	24	46	1779	36	82
1922	28	49	1878	33	83
1921	26	52	1877	29	71
1920	27	52	1876	26	70
1919	31	66	1875	33	88
1918	32	59	1874	32	79
1917	33	69	1873	30	84
1916	34	76	1872	28	70
1915	29	69	1871	28	63
1914	33	70	1870	30	65
1913	28	67	1869	31	64
1912	25	58	1868	28	73
1911	30	75	1867	32	69
1910	27	65	1866	30	65
1909	26	66	1865	32	63
1908	30	66	1864	33	63
1907	31	68	1863	38	66
1906	30	62	1862	31	61
1905	26	59	1861	31	61
1904	31	68	1860	28	63
1903	38	68	1859	29	66
1902	35	60	1858	31	82
1901	34	65	1857	22	61
1900	30	57	1856	27	82
1899	34	61	1855	31	71
1898	36	68	1854	36	93
1897	45	79	1853	32	75
1896	41	71	1852	28	68
1895	40	90	1851	36	79
1894	35	71	1850	37	78
1893	36	71	1849	29	74
1892	31	67	1848	24	72
1891	36	86	1847	27	79

	Bspr.	Wspr.		Bspr.	Wspr.
1846	26	77	1813	33	98
1845	24	74	1812	31	94
1844	21	70	1811	35	103
1843	22	70	1810	36	105
1842	22	72	1809	30	102
1841	21	72	1808	30	116
1840	19	64	1807	26	112
1839	17	79	1806	27	105
1838	14	76	1805	36	106
1837	13	60	1804	31	109
1836	15	71	1803	27	107
1835	15	65	1802	35	122
1834	28	88	1801	35	97
1833	26	81	1800	34	94
1832	23	77	1799	35	105
1831	24	81	1798	36	115
1830	28	95	1797	38	117
1829	24	92	1796	45	119
1828	26	102	1795	34	108
1827	28	90	1794	21	105
1826	31	91	1793	25	105
1825	28	80	1792	29	100
1824	26	71	1791	20	84
1823	25	88	1790	25	92
1822	33	106	1789	25	91
1821	40	96	1788	24	93
1820	28	93	1787	20	89
1819	21	76	1786	28	89
1818	29	86	1785	30	104
1817	29	57	1784	26	87
1816	23	70	1783	22	77
1815	30	87	1782	22	106
1814	33	92	1781	29	78

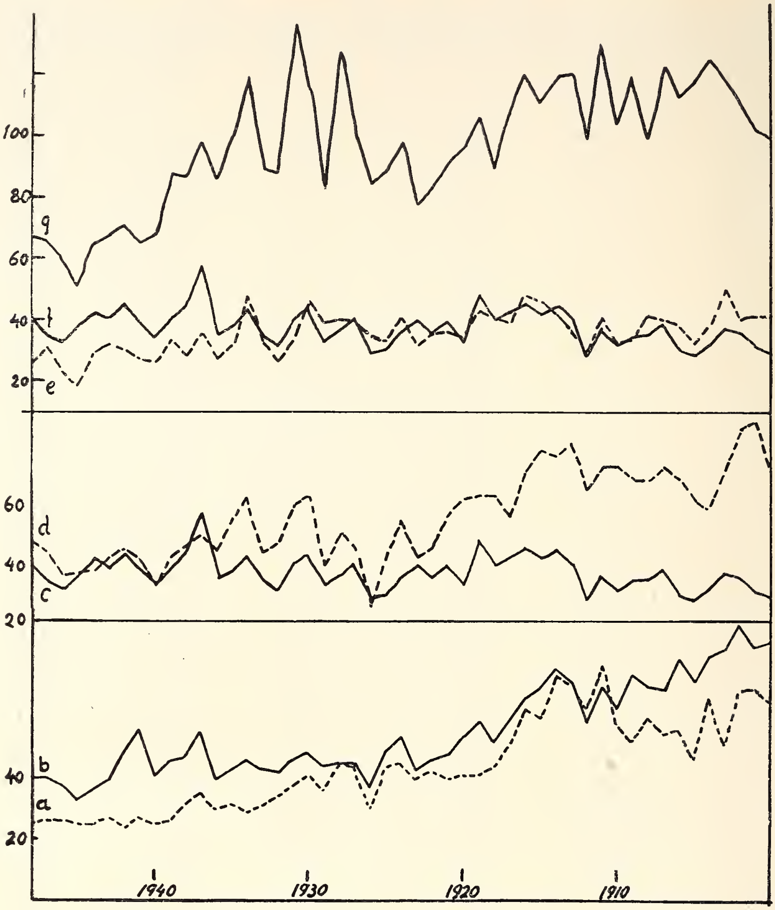

Fig. 28. Tree growth series 1900—48 from Knob Lake, a = black spruce, sample plot 6, lichen forest, b = black spruce, sample plot 9, feather moss forest, c = white spruce and d = black spruce from the same feather moss forest (sample plot 10), e = white spruce from lichen forest (sample plot 3), f = c, g = white spruce from rich forest (sample plot 16). The diagram thus, compares growth series from different forest types and from different species. Note that the »minimum years» (i.a. 1912, 1926, 1936) appear, regardless of species, age and moisture conditions in every graph. For further information, see Tables V—VII.

Diagram 28 compares growth series from spruce lichen forests, feather moss forests and rich white spruce forests in the Knob Lake area. Its purpose is to show the great similarity between the graphs, in spite of the varying moisture conditions. Certain years appear as »minimum»-years in all series; other minimum years are determined by the local microclimate (compare below).

Table VIII. Trees[1] *included in tables V—VII.*

Nr of trees	Sample plot	Height (feet)	D.b.h. (inches)	Approx.age[2] (breast height)
1	5	24	5	164
2	5	21	4	147
3	6	21	6	82
4	6	27	8	91
5	7	36	8	143
6	7	27	5	59
7	9	33	12	128
8	9	36	7	93
9	9	36	7	101
10	10	45	8	997
11	10	42	10	105
12	3	33	9	145
13	3	30	10	146
14	3	27	7	148
15	4	27	11	211
16	4	30	8	247
17	4	24	8	133
18	7	27	7	70
19	7	15	4	97
20	8	36	11	160
21	8	36	9	145
22	8	27	9	144
23	8	27	7	137
24	8	33	9	158
25	10	48	9	129
26	10	45	8	116
27	10	45	8	111
28	10	45	8	124
29	11	30	7	70
30	11	34	8	68
31	11	30	6	70
32	12	54	18	191
33	12	57	12	179
34	12	42	8	152
35	14	45	13	214

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[1] Table V = black spruce, nrs 1—11. Table VI = white spruce, nrs 12—44. Table VII black spruce = nrs 3, 4, 45—47. Table VII white spruce = nrs 12, 14, 16, 20, 24, 32—34, 36—40, 43, 48.

[2] The expression »age» is here merely the number of annual rings at breast height.

Nr of trees	Sample plot	Height (feet)	D.b.h. (inches)	Approx. age (breast height)
36	14	48	19	282
37	15	45	9	97
38	15	48	14	154
39	16	51	28	158
40	16	48	24	162
41	16	36	8	78
42	16	30	8	70
43	18	57	22	178
44	18	54	16	112
45	21	24	7	199
46	14	27	7	143
47	22	24	5	241
48	(p. 40.)	33	9	158

How readily do the trees react to changes in the climate? The cambial activity in the area starts in June and is finished in August; the cambium was »dry» on about the 15th of August in 1948. The radial growth in the north reflects the summer temperature. It has also been found that variations in growth caused by the climate are greater towards the north. It is therefore almost certain that a minimum in the series in Tables V—VII represents years with cold summers in the interior of Labrador.

It should be noted that the radial growth is very slow in these parts, in old trees annually only 0.1—0.2 mm. in thickness. Therefore, the diameter of 100-year-old trees in this area is often comparable to trees 10 to 20 years old at favourable sites in southern Canada. (Note, for instance, the trees No. 1—2 in table VIII). This means that the regrowth of the Labrador forests is a very slow process. Owing to the depressed growth of the seedlings, compare Diagrams 12—15, a tree at about 4 feet's height can be 30 years old, see p. 32. The formation of adventitious roots also adds to the uncertainty of the age determinations, which therefore are restricted to give the number of annual rings at d.b.h. The growth is always more eccentric at the ground, and the trunk at the ground has uneven ridges, which more or less disappear at breast height. The annual variations in growth in thickness are also more unpredictable at the ground than 1.3 m. above the ground. By breast height the tree has a certain »stability», i.e. its growth variations caused by sudden changes in the root system are »smoothed» upwards.

The material above is, of course, poor for dendrochronological purposes. But it is selected in the field from different forest types and is carefully measured. Even a smaller material can give a picture of the annual changes in radial growth in past centuries. In view of the fact that there are no other dendrochronological series from the whole interior of the Peninsula and only two small collections from the Hudson Bay coast (MARR 1948 and H 1950), the series above may have some interest for dendrochronologists and climatologists. Cf. GIDDINGS 1941, 1947.

Diagram 28 illustrates the growth variations of black and white spruce (see also long-term series in Table VII). The same features, certain common minimum- and maximum-years for both series, are marked.

It is of interest to compare the Hudson Bay series (H 1950) and the series from Knob Lake, both black spruce and white spruce. The series from different dry and moist forest types and of different tree species (here only white and black spruce) seem to coincide fairly well. This suggests some other influence independent of the local moisture conditions and probably in some way also quite independent of the local climate.

Between the more pronounced maxima and minima of the growth series there are, of course, less marked minima, »normal» years and years with growth slightly over the average. These smaller »waves» on the graphs are probably more or less a direct result of local climatic and edaphic conditions.

What is the ultimate factor behind the extreme minimum and maximum years occurring simultaneously all over the Labrador Peninsula and, some of them, all over the northern part of the continent? The question prompts speculations in many directions. It, however, takes us away from the firm ground of the Labrador forests.

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ACTA GEOGRAPHICA 13, N:o 2

FOREST-BOTANICAL NOTES FROM THE MOOSE RIVER AREA, ONTARIO, CANADA

BY

ILMARI HUSTICH

HELSINKI—HELSINGFORS 1955

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Introduction

The lower Moose River area, Ontario, was visited by the author in 1946 (July 28th—August 5th, August 11th—13th) and in 1947 (June 21st—July 5th, August 27th—28th).

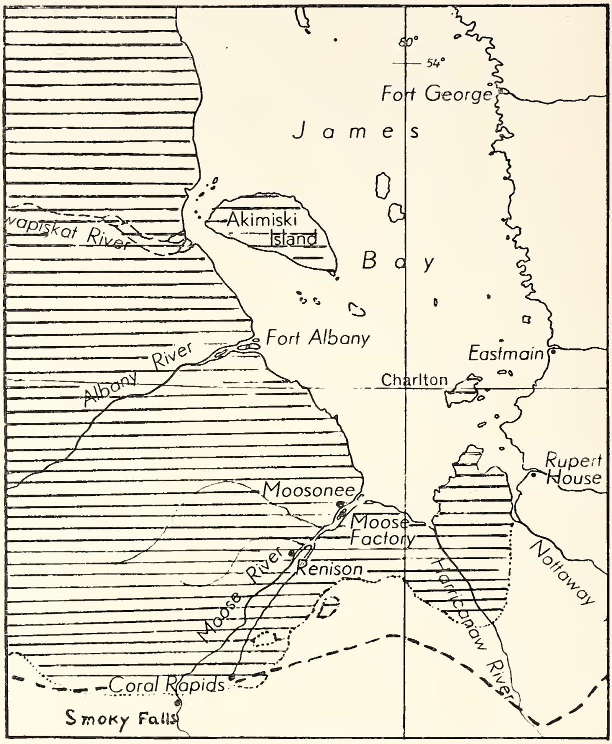
Map 1 shows the area visited and the main points (particularly Renison) studied during the excursions. Regarding localities on the east coast of James Bay visited during 1947, see H 1950. In 1946 the headwaters of the Mattagami River (Moose River Basin) were visited. In 1952 the Renison area was revisited (July 19th—21st) and a short trip was made to Smoky Falls on the Mattagami River N of Kapuskasing.

In spite of the short time the notes were fairly extensive, mainly thanks to the kind help given by my countrymen im Cochrane, Ont., particularly Mr. A. E. Wicks and Mr. and Mrs. Niilo Pitkänen. The lumbermen at the forest camps were very hospitable and helpful. The work in 1946 and 1952 was also greatly aided by Mr. Toby Norell, Montreal.

For all help received the author expresses his sincere gratitude.

Helsingfors, October 1954. *Ilmari Hustich*

I. General Geography of the Moose River Area



Map 1. James Bay and the lower Moose River area. The sedimentary bedrock area is hatched. The broken line indicates the southern limit of the marine submergence.

The area studied in this paper belongs to the sedimentary bedrock area (mostly Devonian) S and W of James Bay. The sedimentary bedrock is covered by marine deposits, a result of the submersion of the area S of James Bay up to about 200 feet above sea-level during the Pleistocene, compare Antevs 1930, Potter 1932 and Lower 1937. As a result of this the country is low and flat with stagnant water, large bogs and mires between the river valleys. Dense forest strips generally only occur along the many rivers and brooks flowing into James Bay. The country thus differs greatly from the Labrador taiga, which generally lies above the highest marine limit and on granite-gneiss bedrock or on very old sedimentary bedrock. In Halliday's general forest classification of 1937 the area is called the »Coastal Plain Region» and Hills (1952) uses the expression Hudson Bay Site Region; it has earlier been described by the great pioneers of the Canadian Geological Survey, R. Bell and A. P. Low. Avoiding unnecessary compilation of already well-known facts, I refer to the publications mentioned above.

The climate is of humid type, see Sanderson 1950, with temperature amplitudes of continental type (Diagram 1 in H 1950)[1]. The annual snowfall is around 75 inches (Hare 1951). Considering the southern situation of the area, about Lat. 51°, the climate is rough; the area lies under the direct influence of the cold James Bay. The summers in the Moose River area are short; the rivers are often still frozen at the end of May. In 1946 for instance, the ice covered Moose River on May 25th and snow could still be found at that date in the Renison forests. The growth season of the trees is only 2—3 months according to my notes; see page 36. In summer the permafrost lies about one foot below the ground in the bogs, according to information from the lumbermen. Wheat ripens in Cochrane but hardly much further north; wheat cultivation has been tried, and in some earlier years with success in Moose Factory. Nowadays (at least in 1946—47), apart from small vegetable gardens, there are only a few hayfields in Moosonee and Moose Factory.

The negative effect of the climate is, however, to a high degree neutralized by the quality of the soil. Owing to the marine submergence during the Pleistocene the soil is clayey and because of the underlying sedimentary bedrock seemingly of a comparatively high lime content. This is particularly evident in the lower reaches of the Moose River, where the flora near the river shore (limestone gravel with fossils is seen here) is astonishingly rich considering its climatically northern situation. On the small area formed by the main points marked on the map 1 the phanerogam flora consisted of about 500 species (see Appendix). The Harricanaw River exploration by Dutilly and Lepage (1952) showed great similarities.

At Coral Rapids and Smoky Falls a strongly marked series of sandy ridges and steep slopes, »the Escarpment», marks the southern limit of the marine deposits; it also marks the general northern limit of jack pine in the area.

From the air the dominance of bogs, mires and swamps is clearly visible, However, no »palsa»-bogs (H 1939) were seen. The tamarack swamps form light green patches in the boggy country but from the air (as from the ground) it appears that a high percentage of the tamaracks on the swamps and bogs are dead. The serpentine course of the numerous small brooks winding through the country indicates the stagnant drainage in the area. Balsam poplar is common and is usually a sign of former burns or cuttings (balsam poplar and aspen are usually left where spruce and fir are cut for pulpwood). Many of the rivers and lakes are dark brown.

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[1] The expressions »H 1939», »H 1950», etc. refer to the author's earlier papers.

The quality of the soil seems to change towards the north, where i.a. the bogs and swamps have a richer vegetation than the bogs farther south. This is due to the rise in the coastline; the muskeg formation is younger near the coast and the influence of the clay and the underlying sedimentary bedrock is thus generally greater than towards the heights of land. However, my notes are not complete enough to give a clear picture of this gradual change in the vegetation.

The forests differ in many respects from the forests in the typical Labrador taiga. Dry forest types are rare in the area because of the general topography. The bog forests (compare e.g. Moss 1953 and H 1949) are particularly large and open in the area. Black spruce muskegs (see H 1949) are widely distributed, forming a belt between the open bogs or mires (usually of so-called »string» type, as in the flat areas of Northern Finland and Russia) and the rich fir and spruce forests along the rivers. Tamarack swamps with rich ground vegetation are common, also secondary forests of balsam fir, balsam poplar and aspen. On the islands in the lower parts of the big rivers white spruce forms high and dense virgin forests with good timber. Earlier travellers in the area, making long and difficult canoe trips along the rivers, have over-

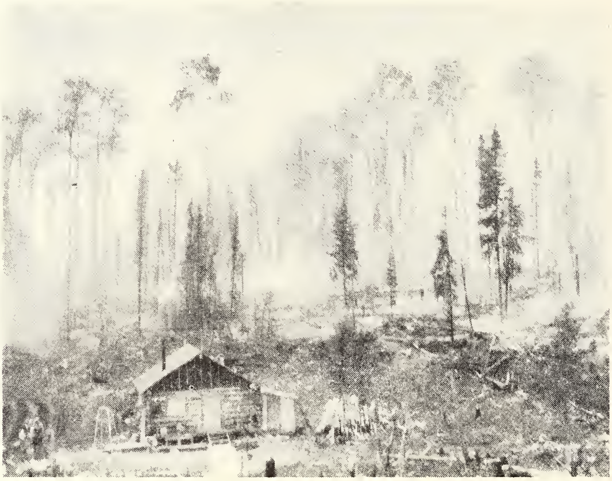
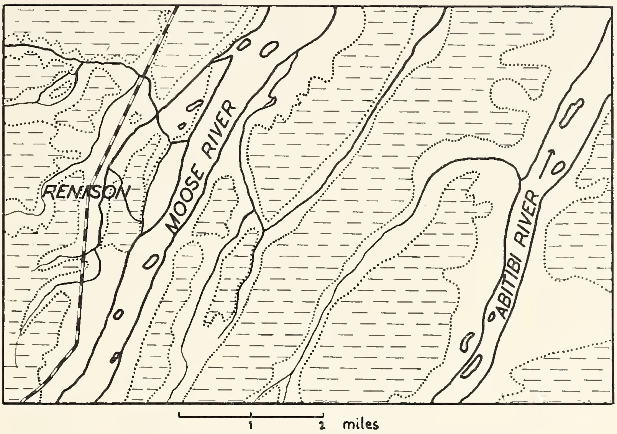


Fig. 1. Forest camp area, illustrating the usual open cutting (with balsam poplar left) in the Moose River area (photo A. E. Wicks).



Map 2. Sketch map showing the Renison area. The broken hatching marks approximately the black spruce muskeg, bog forest and open bog areas between the rivers and rivulets, a terrain pattern typical of the lower Moose River area. Simplified after a forest map by Mr. H. Parsons; used with permission by Mr. A. E. Wicks.

estimated the quality and the density of the forests in the area south of James Bay; only an air survey[1] gives an accurate picture (cf. LOWER 1936).

The influence of man is still small in the area. Formerly the forests along Moose River, Abitibi etc. belonged to the »inaccessible» forests north of the heights of land of Ontario. With the building of the Temiskaming and Northern Ontario Railway from Cochrane to Moosonee in 1922—31, the lumberjacks, mostly Finns, moved in.

The cuttings stopped in 1931 because of the general depression in the forest industries. They were resumed, however, in 1933 and have gradually increased since then. According to information from Mr. A. E. WICKS the amount of pulpwood cut during this time (1925—31, 1933—1948) has been about 150,000 cords from 400 sq.miles of forest in the Moose River area.

The population N of Cochrane is still very small, some hundred Indians and whites. The old post, Moose Factory (erected in 1676), was 1947 practically as small as it was two hundred years ago. Moosonee, the railway terminal, is gradually increasing in size. But generally speaking, the forests in the area are still virgin. All the facts mentioned below concerning the forests and their vegetation apply to virgin conditions unless clearly stated otherwise.

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[1] Mr. A. E. WICKS arranged two air trips for the author in 1946.

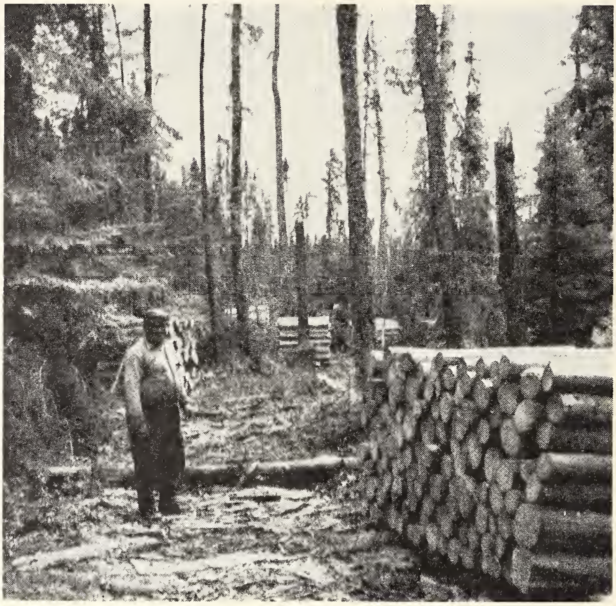

Fig. 2. Peeled pulpwood near the Renison camp (to the left camp manager, Mr. Arvo Pitkänen).

These flat boggy taiga forests on a sedimentary Devonian bedrock have a counterpart in the cold marshy forests on the southern and eastern White Sea coast in northern Russia. Using the ground vegetation analyses by LEONTJEV 1937 a.o. of the White Sea forests and the analyses in this paper as a basis for a comparison, the similarities between these two remote areas are striking. Or rather it might be pointed out that this similarity is by no means remarkable because all Subarctic forests around the polar cap are more or less similar in appearance (see H 1949, H 1953).

II. The Northern Tree-lines in the James Bay Area

The northernmost localities of the tree species mentioned above on the east coast of James Bay and Hudson Bay have been described in H 1950. However, the following facts should be added to this description:

Jack pine occurs on the south coast of James Bay between Point Comfort and Mesakonan Point according to SULLIVAN 1904. At Nastapoka Islands »a few stunted spruce trees grow on the western side of Belanger Sound near the south end of the chain» (LOW 1900, p. 8). These trees are probably white spruce, which seems to be the hardier spruce species on the islands in Hudson Bay, see H 1950.

The following species occur on the main islands in James Bay:

Charlton Island: white spruce, black spruce, aspen, balsam poplar, tamarack, according to LOW 1889, cedar (COATES 1951: the cedar here 1 foot high only). A. E. PORSILD (in letter 1952) also mentions balsam fir, in one place only.

Cary Island: white spruce, black spruce, balsam poplar, white birch; Strutton Island: white spruce, black spruce; Trodily Island: scattered white spruce, up to 14 feet high; Weston Island: some white spruces (all observations according to LOW, l.c.); 12 feet high spruce (COATES, l.c.); Solomons Temple: two patches of 5-foot-high white spruce and dwarfed black spruce (BALDWIN 1953); Pebble Island: »six clumps of spruce not more than 5 feet high» (MANNING 1952, p. 197); South Twin Islands: 8-foot-high white spruce (BALDWIN, l.c.) no black spruce noted North Twin Island: »odd spruce tree growing up to eight feet high» (COATES, l.c.) Akimiski Island: white and black spruce, tamarack, balsam poplar, aspen (A. E. PORSILD, in letter). Re the small islands near the east coast of James Bay see MANNING 1952 and H 1950.

The west coast of James Bay and Hudson Bay is generally less known than the east coast. It is low and the coast-line recedes a mile when the tide comes in. The tree-lines are difficult to map in this area and exact annotations are very scarce in the literature. DOWLING mentions (1914) i.a jack pine and white birch from the Ekwan River; particularly his note of jack pine growing about 50 miles from the mouth of the Ekwan River is of interest; this locality considerable changes the map of the jack pine tree-line as shown, for instance, in H 1949.[1]

Re cedar logs in the driftwood strand lines, see MANNING 1951.

III. Tree and Bush Species in the Moose River Area

The following tree species occur in the Moose River area: black spruce (*Picea mariana* (Mill.) BSP), white spruce (*P. glauca* (Moench) Voss), balsam fir (*Abies balsamea* (L.) Mill.), tamarack (*Larix laricina* (DuRoi) Koch.), cedar (*Thuja occidentalis* L.), jack pine (*Pinus Banksiana* Lamb.), balsam poplar (*Populus balsamifera* L.), aspen (*Populus tremuloides* Michx.) and white birch (*Betula papyrifera* var. *commutata* (Regel) Fern. and var. *cordifolia* (Regel) Fern.).

Elm (*Ulmus americana* L.) and black ash (*Fraxinus nigra*) occur at Island Falls 40 miles N of Cochrane (Mr. D. McLean, verbal inf. 1952), other hardwood tree species farther south; see the »main tree-line» in H 1949. Red pine (*Pinus resinosa*) occurs (A. E. Wicks; information in letter 1953) 20 miles SW of Cochrane; white pine (*P. strobus*) occurs only at one point N of the CN-Railway (A. E. Wicks, l.c.). This area seems generally to support FERNALD's theory (1919) of the different ecology of cedar and jack pine; the former prefers according to Fernald less acid soil than the latter; cf .RAYMOND 1950 and H 1950. DUTILLY and LEPAGE (1952) have the same opinion of the Harricanaw area; they add, however; »sur les rochers feldspathiques, il n'est pas rare d'observer les deux arbres croissant côte a côte» (l.c., p. 19).

White spruce occurs mostly near the river itself, black spruce also on the bogs between the rivers. Tamarack is common but never forms dense stands; tamarack swamps with scattered trees can be seen all over the area from the air. The species seems to be expanding again on the swamps after the heavy destruction wreaked by the larch saw-fly about 40 years ago. Balsam fir is common near the river, where it is usually intermingled with other tree species. Re jack pine see p. 30. Aspen and balsam poplar form (young) pure stands only on earlier burns. White birch seldom forms pure stands; it occurs intermingled in the forests near the river and on the burns, as does cedar on scattered small cedar swamps of the kind described below on p. 21. Cedar grows on Moose Factory Island as bushes only.

A few remarks re the *tree size:* The best-grown white spruce attains a height of about 105 feet (40 inches d.b.h.) on the »white spruce» islands in Moose River some miles below Renison; the age of these good timber trees is about 125—150 years. The oldest white spruce noted measure d about 200 years. Black spruce ot such sizes has not been seen; the best-grown black spruces — near the river — measured by the author were about 60—65 feet (10 inches d.b.h.). The oldest black spruce measured was about 200 years. Balsam firs, 60 feet high and 20 inches d.b.h. (about 130 years old) has been noted in the area. The tamarack are generally small, reaching at most 50 feet in height with a d.b.h. of 10 inches. The cedar trees, generally rotten inside, were at most 30 feet high and 10 inches d.b.h., the oldest cedar measured at least 200 years. Only near Cochrane did the cedar log seem to be of good quality. Several old big white birches were seen, up to 60—70 feet in height. Aspen trees and balsam poplar (oldest measured tree about 120 years), 60—75 feet high and 20 inches d.b.h. occur in the area. Speckled alder reaches about 15—18 feet in height. (*Prunus virginiana* reaches nearly tree size, 18 feet in height, at McInnis; *Salix* cfr *planifolia* and mountain ash reach 24 feet in height.)

*

The commonest bush species in the forests in the area are Labrador tea and speckled alder (*Alnus rugosa* var. *americana*). The other alder species in the James Bay area, *Alnus crispa*, is scarce in the Moose River area according to the author's notes. On the James Bay coast itself, however, *Alnus crispa* is very common. Mountain ash (*Sorbus decora*) grows intermingled in the forests along the river, frequently forming vegetative shoots in the older virgin forests.

As usual in the taiga the Salices are common along small brooks in the forests and at the margin of small swamps, etc. The following willow species appear in my collections (cf. FAGERSTRÖM 1949 and HIITONEN 1950): *Salix discolor* (var. *latifolia*), *S. adenophylla, S. pedicellaris* var. *hypoglauca, S. Bebbiana, S. myrtillifolia, S. lutea, S. pyrifolia, S. lucida, S. glaucophylloides, S. cordata* Muehl. var. *abrasa* and *S. interior*. Compare list of Renison plants on p. 44-48.

In the rich groves near the Moose River several bush species, somewhat rare here, were collected: *Juniperus communis,*[1] *Acer spicatum,*[2] *Amelanchier Bartramiana* (also some other *Amelanchier* species, impossible to determine with certainty), *Cornus stolonifera, Elaeagnus argentea, Physocarpus opulifolius, Potentilla fruticosa, Prunus virginiana* (only at McInnis Siding), *Rhamnus alnifolia, Ribes americanum, R. hudsonianum, R. triste, R. glandulosum, R. lacustre, Rosa acicularis, R. blanda, Sambucus pubens* and *Viburnum pauciflorum*. Note the absence (at least in the notes) of *Myrica gale*.

Of the birch species all except *Betula papyrifera* attain only bush size. POTTER (1934) mentions *B. minor* from the area; also found by the author. *B. glandulosa* occurs in the muskegs and the bogs but is not nearly as common here as farther north. *B. pumila* var. *glandulifera* was also collected in the area by the author in 1946 and 1952.

If we compare the 21 species of bush species mentioned in H 1950, covering the area from Rupert House to Great Whale River, the list above with its many species (found on the very limited area shown on Map 2) is very impressive. It is clear evidence of the influence of the good edaphic conditions, particularly along the Moose River itself.

IV. The Forests in the Moose River Area

The main forest types (described in H 1949), in the area are the following: black spruce muskeg, mixed feather moss forest, rich white spruce forest and secondary[3] balsam poplar-aspen forests.

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[1] *J. horizontalis* noted on Charlton Island by A. E. PORSILD (comm. in letter).

[2] Noted by COATES (1951) on Charlton Island; probably its northernmost locality in the area.

[3] Secondary forests here means forests developed after fairly recent fires or cuttings.

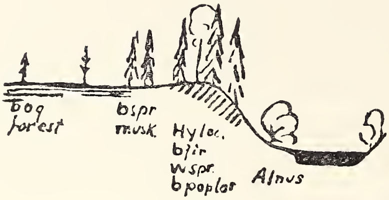

Fig. 3. Rough sketch drawing of the distribution pattern of forest types along brooks and rivulets in the area.

There are thus practically no forest types belonging to the dry forest types in the area. The reason is the absence of larger sandy or moraine areas. There are, for instance, no spruce lichen forests or jack pine blueberry forests in the whole area, except near Coral Rapids and Smoky Falls, see p. 30.

The main forest types are distributed in the Moose River area according to the pattern illustrated by Map 2, a detail of a map in the office of Mr. A. E. Wicks in Cochrane. Fig. 3 shows how the drainage affects the distribution of the main forest types near the rivulets and rivers.

Before going into details of the sample plots some general information on the forests is called for. The black spruce pulpwood forest in the area gives an average of about 15 cords per acre (35 cords in good black spruce forest; about 12 cords is probably the usual average in Northern Ontario). The general composition of commercially exploited forests in the area is 75 % black spruce, 20 % white spruce and 5 % balsam fir. Sawmills operate at McInnis Siding and at Moose River Crossing. A minor sawmill, for local use only, has been in operation at Moosonee.

In 1951 the Ontario Dept. of Lands and Forests planted several thousand white spruce seedlings on an island in the Abitibi near Renison. This interesting project has not, however, according to information from the lumbermen, entirely succeeded.

Re the reproduction[1] on different forest types, compare the descriptions of the sample plots.

A careful microscopical examination of the age of 195 spruce seedlings seemed to show no particular marked seed year; there is probably some sort of »seed year» every year for the spruce in the area. The material is, however, too small to allow any conclusions.

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[1] Re the identification of spruce seedlings I can support PLACE's findings (1950 c): fine saw teeth occur on the margin of young needles of white spruce. Also, the white spruce usually has 6 cotyledons. An other minor detail, which I have not seen mentioned in the literature, is that white spruce shoots also sometimes have — very scarce — small hairs. Such hairs are, however, always formed by one cell only, whereas the usual hairs on the black spruce shoots always have 3—6 cells.

The *sample plots* are from the following places, marked on Map 1:

Renison is about 156 miles N of Cochrane along the railway. The notes (see Introduction) are from the flat country (Devonian bedrock) near the forest camps (Niilo Pitkänen), from the poor muskegs farther from the river (on both sides) to the rich white spruce forests E of the Moose River; the river here is broad and fast-flowing with clayey banks about 20 feet high. Fig. 12 is from this river shore and Fig. 6 from the forests here. This is the main part studied; most of the sample plots and observations belong to this locality.

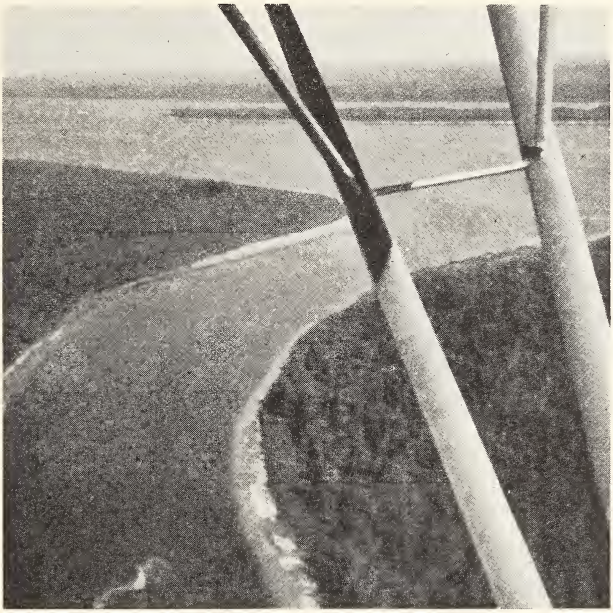

Fig. 4. The low country near Moosonee and Moose Factory.

Moosonee is the terminal of the railway, a small place (in 1947) with a church and a mission station, a Hudson Bay Co. post, etc., about 30 miles N of Renison. Around the terminal are young balsam poplar and aspen forests on recent cuts or burns but also open tamarack swamps with rich vegetation. The country is very flat and clayey; see Fig. 4. The notes are very incomplete.

Moose Factory is an old Hudson Bay Co. post situated on a big island in the mouth of the river, often described in travellers accounts from James Bay.

The island is low; it was once (1877?) completely flooded. Today it is covered ni young forests rich in herbs, with white spruce, balsam fir and balsam poplar and some cedar thickets. The notes were made during an enforced stay in 1947 before going north.

McInnis Siding, a small railway station 42—43 miles N of Cochrane near the sawmill and near Abitibi River. The country is flat and clayey (probably rather high pH values) and the dominating tree species in these young secondary forests are balsam fir and balsam poplar.

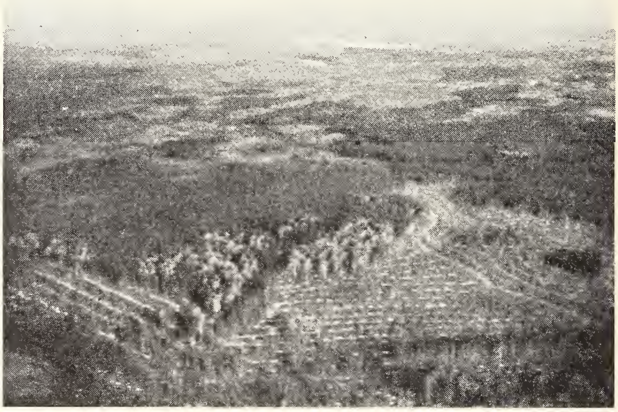

Fig. 5. The pulpwood cutting marches northwards in the area between Cochrane and McInnis.

(*Smoky Falls*. A few notes on the forests were made during a two days' stay in 1952 (July 16th—17th), particularly of jack pine forests near the village Smoky Falls on the Mattagami River, a tributary of the Moose River.)

*

The sample plots are described in brief below. Their area, unless otherwise stated, is about 1/40 acre, i.e. about 10×10 m. The analyses of the ground vegetation on a typical 6×6 ft. area of the sample plot are based on ocular estimation only. The abundance of a species on the sample plot is given as follows: 3 = dominant, 2 = common, 1 = scattered, × = occasional individuals of a species.

The phanerogams collected in the area (see p. 44) were mainly determined by my collegue, Lars Fagerström, M.A., with the help of many specialists,

A. E. PORSILD, MARCEL RAYMOND a.o. (FAGERSTRÖM 1949). The field determinations of the bulk of the plants of the ground cover vegetation in Tables 1—3 were made by the author; in uncertain cases the plants were collected and determined later. Many *Salices* were determined by Dr. HUGH M. RAUP (cf. HIITONEN 1950). The mosses mentioned below have all been determined by Dr. RISTO TUOMIKOSKI; most of the lichens were determined by Dr. STEN AHLNER, Uppsala, some by Dr. VELI RÄSÄNEN († 1953). The increment cores were measured by Mr. FRITZ BERGMAN, Forester, and Mr. N. H. SKULT, M.A. For all this aid I here express my deep gratitude.

Abbreviations: river = Moose River, wspr = white spruce, bspr = black spruce, alder = *Alnus rugosa* var. *americana*, fir = balsam fir, poplar = balsam poplar, *Hylocomium* = *Hylocomium splendens*, *Pleurozium* = *Pleurozium Schreberi*. The expression »30 × 6, age 80, at the ground 90 years» means a tree on the sample plot, 30 feet high, 6 inches in diameter at breast height (d.b.h.), age 80 years (according to microscopical measurements of cores obtained with an increment borer) at breast height and 90 years at the ground. — The expression »12 × 16y» means a seedling 12 inches high and 16 years old according to microscopical determination. The age of the seedlings refers to conditions in 1947. The difficulty of obtaining appropriate age determinations of spruce seedlings in the north has been stressed earlier by the author (H 1950).

Black spruce muskeg

Black spruce muskeg[1] means here a fairly wet black spruce forest with a ground vegetation of *Ledum groenlandicum*, *Kalmia angustifolia* or *Chamaedaphne calyculata* on a moss floor of dominating *Sphagnum*. As can be seen from Fig. 3 these forests here form a transition belt between the open bogs and the moist forests on the banks and terraces near the rivers and brooks. This forest type is common in the taiga, where there are extensive areas vith slow drainage; its occurrence in the Moose River area is partly restricted by the limecontent of the soil. *The sample plots 1—11 are from the Renison area.*

1. Bspr muskeg between the railway (mileage 156) and the river. Only one pulpwood-sized tree on abt. 400 sq.metres. Several bspr thickets formed by vegetative propagation. Trees: *24* × *4*[2], age 120, at the ground 170, *18* × *2*, age 105.

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[1] Re the expression »muskeg» see i.a. KÜCHLER 1947 and H 1949.

[2] Italicized numbers (*24* × *4* etc.) refer to trees included in Table IV—V.

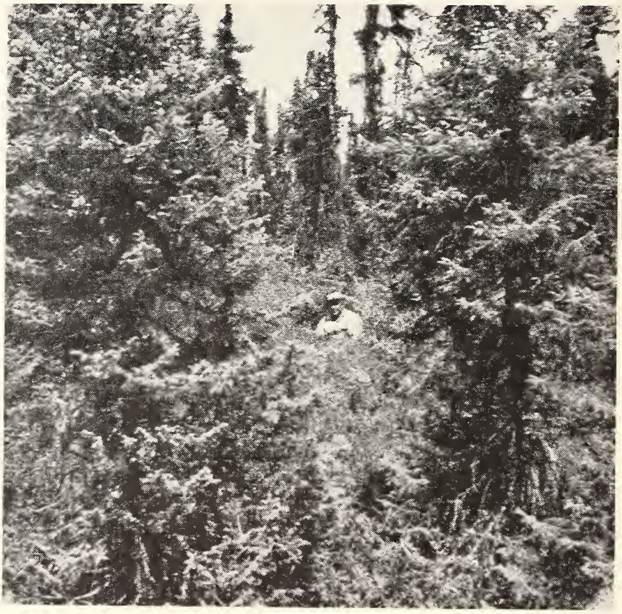

Fig. 6. Typical black spruce muskeg east of Moose River.

Reproduction: apart from vegetative propagation the following seedlings: 11 × 18y, 12 × 21y, 9 × 15y, 14 × 15y, 15 × 17y, 17 × 16y, 13 × 23y, 10 × 12y, 9 × 15y, 6 × 6y. Dominant *Sphagnum fuscum* and *Polytrichum strictum:* on drier tussocks *Cladina mitis, C. gracilis, C. crispata, C. deformis* and *C. cristatella.*

2. Bspr dominated muskeg forest with scattered tamaracks (near mileage 156) W of the river. The trees, mostly 33—36 feet high, slightly sloping, with narrow crowns and excentric growth; see Fig. 6—7. Undergrowth of scattered bspr and thickets and low bspr bushes. On 1/40 acre the following trees: bspr *42 × 6,* age 155, at the ground 165 years, *42 × 6,* age 97, at the ground about 110 years, *36 × 6,* age 97, *30 × 4,* age 97, *39 × 7,* age about 115; tamarack 42 × 10, age 143.

Reproduction: good, on each sq.metre 7—8 bspr seedlings, 1—3 years old, distributed in groups on the sample plot. The age of some seedlings measured (age in 1947): 10 seedlings one inch high and 2 years old, two seedlings 5 years old and one older seedling (9 × 17y). Dominant *Sphagnum acutifolium* with scattered *Pleurozium* and *Hylocomium* (incl. *Barbilophozia barbata*).

3. Bspr muskeg with about 5—6 trees on 1/40 acre W of the river (mileage 156). Trees measured: bspr *27 × 6,* age 100, at the ground 110 years, *24 × 4,* age 85, *21 × 3,* age 85—95, at the ground 100 years, 18 × 2 ½, age 100, at the ground about 110 years. Vegetative propagation very common. No seedlings. Dominant *Sphagnum fuscum* and *S. acutifolium.*

4. Bspr muskeg with timber-sized trees on swampy slope (mileage 157) 1/3 mile W of the river. No bush cover on the sample plot, but nearby good vegetative propagation of bspr and fir. The trees measured: *60 × 10,* age 154, *39 × 6,* age 150, fir 36 × 7, age 68, at the ground 97 years. Good reproduction: on Sphagnum-covered places many seedlings, about 8 bspr and 4 fir (about 2 years old) seedlings on each sq.metre; no seedlings on the Hylocomium-tussocks. Bspr seedlings: 16 × 25y, 15 × 23y, 11 × 16y, 6 × 12y, 5 × 10y, 4 × 8y, 6 × 9y, 3 × 7y, 2 × 3y, 3 × 4y, 2 × 3y, 1 × 2y, two 1-year seedlings and one 5 years old. Dominant *Sphagnum acutifolium;* on tussocks *Hylocomium.*

5. Near camp at Renison, about ½ mile W of the river. Good pulpwood-sized bspr stand. Some trees: 33 × 5, age 130, 36 × 5, age about 100, 39 × 8 ½, age 103 years. No seedlings, some vegetative shoots only. On small tussooks, contrary to the usual pattern, dominant *Sphagnum acutifolium* and *S. robustum,* incl. *S. magellanicum, S. angustifolium* and *S. fuscum;* on the places between or in slight depressions *Pleurozium* and *Dicranum rugosum* (= *D. undulatum*).

6. Mileage 156, abt. ½ mile E of the railroad, An intermediate type on the border of a typical muskeg. Dominant bspr with scattered fir. An under-story

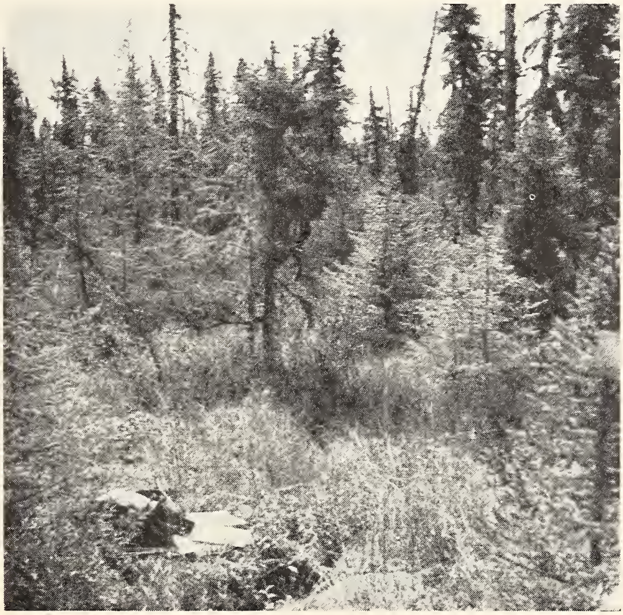

Fig. 7. Transition between black spruce muskeg and bog forest, near sample plot 11.

of dominant fir (15—24 feet) and scattered alder bush. Samples of trees: bspr *48 × 9*, age at least 175, *48 × 12*, age abt. 130, 27 × 5, age abt. 70, fir 21 × 4, age 30. Reproduction: satisfactory of bspr (seedlings and vegetative shoots), incl. scattered fir (2 seedlings measured: 2 and 6 years old) tamarack and one mountain ash-seedling. Cryptogams: dominant *Sphagnum fuscum* and. *S. nemoreum*, incl. *Pleurozium*, *Aulacomnium palustre*, *Mnium pseudopunctatum* and *Dicranum Bergeri;* no lichens.

7. Bspr muskeg on the borders of the large bogs E of the river (near Renison). On 1/40 acre the following trees: *33 × 6*, age about 95, *36 × 7*, age about 150, *45 × 10*, age 95—100, 24 × 4, age 87, *45 × 7*, age 128 years. The trees slightly sloping with very excentric growth in thickness and with hard depressed wood. Reproduction: many seedlings, up to 1 m. high, but also rich vegetative propagation. — Dominant *Sphagnum robustum* and *S. parvifolium*, scattered patches with *Pleurozium* and *Ptilium crista-castrensis*.

8. About 1 mile E from the river (1952) bspr muskeg with trees mostly about 27 feet in height and 5 inches in diam. Scattered tamaracks. Trees measured: bspr 42 × 8, 33 × 6, 42 × 10, 21 × 3, tamarack 27 × 5. No reproduction, only vegetative shoots. — Dominant *Sphagnum fuscum* and *S. acutifolium*, scattered *Pleurozium*, incl. *Polytrichum strictum*, *Dicranum rugosum*, *Ptilidium ciliare* and *Peltigera aphthosa*.

9. About 1.5 mile E from the river (1952). The bspr here mostly 24—32 feet in height and 2—4 inches in diam. Nearby an open bog. No seedlings, but vegetative reproduction of about 3-foot-high thickets. About one pulpwood-sized tree every ten m. Earlier more tamarack on the sample plot because every 1/40 acre had 3—4 dead tamaracks. Trees measured: 27 × 5, 7 × 2, 24 × 4, 24 × 3. Dominant *Sphagnum fuscum* and *S. parvifolium*.

10. About 1.5 mile E of the river an open bog forest (1952) with small 15—20-foot-high bspr, some young tamaracks 6—7 feet in height and some dead tamaracks with winded stems. Earlier more tamarack, which was succeeded by bspr; now again tamarack seems to be more active. Very saturated habitat. Trees measured: bspr 15 × 3, half dead; 21 × 3, tamarack 12 × 2, dead tamarack 21 × 4. No seedlings. Dominant *Sphagnum fuscum*, *S. parvifolium* and S. cfr. *magellanicum*.

11. The sample plot, like N:o 9, shows the gradual transition from a bspr muskeg into a »forest of sticks» (open bog forest) with scattered *Betula pumila* bushes. The following trees (all slightly sloping, with excentric growth in thickness) on 1/40 acre: *27 × 5*, age 155, *27 × 6*, age 120, *33 × 7*, age 140, 27 × 4, age 80, tamarack 15 × 3, age 115. Cone production of bspr satisfactory, but only 4 bspr seedlings (5 × 8y, 1 ½ × 3y, 5 × 5y, 6 × 9y). Fairly good vegetative propagation. Half of the area with *Sphagnum acutifolium* and *S. fuscum*, the other half with *Pleurozium*, *Dicranum rugosum*, *Pohlia nutans* and *Ptilidium pulcherrimum*. On small tussocks *Cladina rangiferina*, *C. mitis*, *C. alpestris*, *Cladonia fimbriata* and *Peltigera scabrosa*.

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The *epiphyte lichen flora* (collected from 4 sample plots only) of the muskeg trees in the area is remarkably stable in its composition: *Alectoria jubata* coll. (= the usual »black beard» lichen; on sample plots 3, 5, 7, 10), *A. nidulifera* (3, 5, 7, 10), *Evernia mesomorpha* (3, 5, 7, 10), *Usnea* sp. (3, 7, 10), *Parmelia physodes* (3, 5, 7), *P. sulcata* (5, 10), *P. obscurata* (7, 10; cf. LEPAGE 1949), *Parmeliopsis aleurites* (5, 7, 10), *P. ambigua* (5, 10), *P. hyperopta* (7, 10) and *Cetraria ciliaris* (5, 7, 10).

Table I. The ground vegetation (vascular plants) on the sample plots 1—11, black spruce muskegs.

	1	2	3	4	5	6	7	8	9	10	11
Ledum groenlandicum	3	2	2	2	2	2	1	2	2	2	×
Kalmia angustifolia	1	2	2	3	2	1	1	1	—	2	—
Chamaedaphne calyculata	2	2	2	—	2	—	2	—	2	—	×
Rubus chamaemorus	×	×	×	—	1	1	2	×	1	1	—
Kalmia polifolia	1	—	×	—	—	—	×	×	×	×	1
Oxycoccus microcarpus	1	—	×	—	—	—	—	—	×	×	—
Smilacina trifolia	×	—	×	—	1	×	1	—	1	—	1
Vaccinium Vitis-Idaea	—	1	—	1	1	1	1	1	—	1	—
Gaultheria hispidula	—	1	—	1	1	1	1	×	×	1	×
Pyrola minor	—	×	—	—	—	—	—	—	—	—	—
Ranunculus lapponicus	—	×	—	—	—	×	—	—	—	—	—
Carex pauciflora	—	—	×	—	—	—	—	—	×	—	—
Carex disperma	—	—	×	—	—	×	×	—	—	—	—
Carex chordorrhiza	—	—	×	—	—	—	—	—	—	—	—
Eriophorum spissum	—	—	×	—	—	—	—	—	—	—	—
Geocaulon lividum	—	—	—	×	×	—	—	—	×	×	—
Equisetum sylvaticum	—	—	—	1	—	×	—	1	—	1	—
Carex trisperma	—	—	—	—	×	×	—	—	—	—	—
Rubus pubescens	—	—	—	—	—	×	—	—	—	—	—
Linnaea borealis	—	—	—	—	—	×	—	—	—	—	—
Coptis groenlandica	—	—	—	—	—	×	×	—	—	—	—
Vaccinium myrtilloides	—	—	—	—	—	×	—	—	—	×	—
Vaccinium angustifolium	—	—	—	—	—	—	—	×	—	—	—
Pyrola secunda	—	—	—	—	—	—	—	—	—	×	—
Carex paupercula coll.	—	—	—	—	—	—	—	—	—	—	2
Andromeda glaucophylla	—	—	—	—	—	—	—	—	—	—	×
Number of species (26)	7	8	11	6	9	14	10	8	9	11	7

Mixed swamp forests

The black spruce muskeg is a swamp or bog forest, but the expression »swamp forest» as used here means a type of wet forest richer in herbs where the dominant tree species is tamarack, white spruce or cedar and where black spruce, if present, is faster growing than on ordinary muskegs. The swamp forest is more luxuriant, and its moss cover is not dominated by »peat moss» (*Sphagnum*) but by *»brown mosses»* (i.e. *Paludella, Tomentypnum, Drepanocladus, Campylium,* etc.). Such forests in northeastern Canada are, for example, the tamarack swamps described in H 1950 and H 1954.

12. McInnis. A bspr swamp with rather luxuriant vegetation. The trees scattered, well-grown, samples of bspr measured: 24 × 4, age 41, 27 × 4, age 54, 27 × 5, age 61. Bush cover of *Alnus crispa* 2, *Ribes glandulosum* +, *Salix cordata v. abrasa* +. Vegetation cover: *Rubus pubescens* 2, *Cornus canadensis* 1, *Ledum groenlandicum* 1, *Dryopteris cristata* +, *Dryopteris Linnaeana* 1, *Linnaea borealis* 1, *Lonicera villosa* 1, *Carex leptalea* +, *Coptis groenlandica* +, *Galium triflorum* 1, *Chimaphila umbellata* +, *Kalmia polifolia* +. Cryptogams: mostly *Sphagnum Warnstorfianum* with *Hylocomium, Pleurozium, Polytrichum* sp., *Ptilium crista-castrensis* and scattered *Cladina rangiferina*. No notes on reproduction.

13. Moosonee. Tamarack and bspr swamp about 1 mile from the station. Mostly tamaracks. 21 × 2, age 60—65 years at the ground, 21 × 2, age 21, 21 × 2, age 25—30, 21 × 2, age 23 including bspr: 21 × 4, age about 30, 21 × 2, age about 30. The tamaracks half dead, see p. 10, lichen-covered, often rotten. Bush cover composed of *Salix pedicellaris* var. *hypoglauca* and *Betula glandulosa*. Ground vegetation: *Ledum groenlandicum* 2, *Carex paupercula* 1, *Chamaedaphne calyculata* 1, *Gaultheria hispidula* +, *Equisetum fluviatile* +, *Drosera rotundifolia* +, *Carex gynocrates* +, *C. angustior* +, *Petasites palmatus* +. Cryptogams: *Tomentypnum nitens, Aulacomnium palustre, Cratoneurum* ?, *Helodium lanatum, Paludella squarrosa, Sphagnum Warnstorianum* and *S. nemoreum*. Epiphyte lichens on tamarack: *Alectoria nidulifera, A. simplicior, Cetraria ciliaris, C. pinastri* and *Parmelia sulcata*. 7 tamarack seedlings measured: 8 × 5—6y, 14 × 5y, 8 × 6y, 14 × 6y, 4 × 6y, 5 × 5—6 × 6y and one bspr seedling 5 × 3—4y. 5—10 tamarack seedlings/sq.metre; only vegetative propagation of bspr.

14. Renison. Luxuriant swamp forest plot near the W shore of the river. Trees scattered: wspr (54 × 18), bspr (36 × 6), bfir (36 × 6), poplar (38 × 7); white birch, cedar and aspen in the neighbourhood. Bushes: dominant alder, incl. *Cornus stolonifera, Rhamnus alnifolia, Salix* cfr *planifolia* (18 feet high) and *Viburnum edule*. Ground vegetation: *Rubus pubescens* 2, *Smilacina trifolia* 1, *Cornus canadensis* 1, *Lonicera* cfr *canadensis* 1, *L. involucrata* 1, *Aralia nudicaulis* 1, *Equisetum pratense* 1, *Geum rivale* 1, *Ribes* sp. +, *Rosa acicularis* +, *Galium triflorum* +, *Mitella nuda* +, *Ranunculus lapponicus* +, *Carex disperma* +, *C. leptalea* +, *Pinguicula vulgaris* +, *Parnassia caroliniana* +, *Caltha palustris* +, *Thalictrum* sp. +. Small water patches between the decaying stems in the neighbourhood.

A typical sample of the small swamps along the river with luxuriant »calciphile» vegetation. Good reproduction of fir seedlings, about 5/sq. metre, scattered wspr, bspr, white birch, mountain ash and poplar seedlings, about 100 cedar seedlings; samples of age classes among the cedar seedlings: 2 × 2—3y, 2 × 3y, 2 × 2—3y, 2 × 2y, 5 × 8—8y, 6 × 9y, 8 × 11y, 9 × 18y. The young cedar seedlings easily form adventitious roots. The area is covered by the spring flood; note the cryptogam cover: *Climacium dendroides, Distichium montanum, Rhytidiadelphus triquetrus, Brachythecium* sp., *Philonotis* sp., *Thuidium* sp., etc.; no lichens.

15. Renison. Cedar grove near the W shore of the river. Trees: 14 cedars including 4 dead and 3 with dry crowns. Every cedar with heart rot. On the same plot scattered poplar, wspr, bspr and tamarack. Some cedar trees: 33 × 11, 21 × 5, 39 × 8, 36 × 12, age of all about 200 years. A big white spruce (24 inches d.b.h.) nearby was 190 years. Only the last twenty annual rings still intact in the old cedars; the rest of the stem rotten. In the bush-cover alder dominant, incl. low fir. The plot, flooded over in spring, is rich in herbs: *Smilacina trifolia* 2, *Rubus pubescens* 2, *Cornus canadensis* 1, *Mertensia paniculata* 1, *Ribes* sp. 1, *Mitella nuda* 1, *Ranunculus lapponicus* +, *Habenaria obtusata* +, *Carex gynocrates* +, *Viola pallens* +, *Anemone quinquefolia* +, *Linnaea borealis* +, *Galium boreale* +. — Cryptogams: *Hylocomium, Climacium dendroides, Thuidium Philibertii, Thuidium delicatulum, Hypnum arcuatum, Rhytidiadelphus triquetrus, Drepanocladus uncinatus, Eurhynchium* sp., *Mnium rugicum, Brachythecium* sp. Good cedar reproduction, samples: 3 × 3—4y, 2 × 7y, 4 × 4—5y, 5 × 6—7y, etc.: 2—3 seedlings/sq.metre. About 5—6 fir seedlings/sq.metre. Scattered alder and poplar seedlings, incl. vegetative reproduction.

16. Near sample plot 15. A small detail study of the seedling growth on a fallen bspr stem surrounded by wet swamp vegetation, exemplifying the reproduction intensity on rotten wood[1] in an opening of a virgin swamp forest on good soil. The stem probably decaying for 20—30 years. The decaying stem (10 metres from a cedar tree) entirely covered by mosses. The phanerogams (on only 1 metre of this half-decayed stem, 20 cm wide): *Parnassia caroliniana* 4 individuals, *Pinguicula vulgaris* 4 ind., *Ranunculus lapponicus* 3 ind., *Carex disperma* 1 ind., *Smilacina trifolia* 2 ind., 6 *Ribes* seedlings and 2 *Salix* seedlings. 17 different moss species on this piece of decaying wood: *Mnium rugicum, M. marginatum, Drepanocladus aduncus, D. uncinatus, Hypnum arcuatum, Rhytidiadelphus triquetrus, Cratoneurum filicinum, Campylium stellatum, C. polyganum, Bryum ventricosum, Timmia megapolitana, Distichium montanum, Thuidium* sp., *Amblystegium riparium, Pohlia* sp. — 21 seedlings on this »bed» 1/5 sq. metre: 7 cedar seedlings, of which one 3 × 4—5y, the others 1 × 1— years; fir: 1 × 2y, 2 × 5y, 5 × 14y, 4 × 9—11y, 2 × 3—4y; Vspr: 4 × 8y, 3 × 4y. 1 × 3y, 2 × 5—6y, 3 × 6—8y, 4 × 5y, 4 × 6—7y; birch: 2 seedlings (1—2 years),

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[1] Cf. PLACE 1950 a.

Mixed black spruce—balsam fir forests

This group includes sample plots forming a transition from the moist black spruce forest with muskeg characteristics (*Ledum, Rubus chamaemorus, Sphagnum*) into more or less pure feather moss forests with old black spruce and balsam fir or white spruce. In the feather moss forests the moss species (see below p. 33) dominate and the vascular plants are scattered remnants only of an earlier probably richer flora on the spot. In this area such forests are, however, rather rare; they occur more frequently in the typical Labrador taiga on the Archaean shield. The same applies to homogeneous black spruce stands of *Cornus—Vaccinium* type. The low terrain with good drainage only on rather small areas around the creeks and rivers favour the formation of muskegs and swamps and allows only smaller patches with moist or more or less dry forest types, see p. 12.

17. E of the river abt. 2 miles from the camp. Dominant bspr (sample trees *54 × 10*, age 80, *51 × 10* age abt. 110) and scattered fir (sample trees: 54 × 8.5, age abt. 60, 27 × 4, age 45). The under-story formed by fir, alder, mountain ash, reaching 18 feet (sample tree: 15 × 3, age abt. 35) and *Salix myrtillifolia* Anders. Reproduction: Abt.5 fir seedlings on one sq. metre and abt. 5 bspr seedlings on one sq. metre. One birch seedling, 6—7 years, and 2 mountain ash seedlings 5 and 12 years old. Cryptogams: *Pleurozium, Hylocomium, Ptilium, Drepanocladus uncinatus, Sphagnum Girgensohnii, S. Wulffianum, S. parvifolium* and *S. squarrosum.*

18. Near a small brook 1 mile from the Renison camp, between muskeg and drier bspr forest, see Table II. Well grown bspr: *54 × 8*, age 110, at the ground 116, *54 × 11*, age 110, at the ground 120, *48 × 5*, age 110. Among bspr scattered tamarack (sample 57 × 11, age 115) and younger fir (*21 × 4*, age 25—30, at the ground 60—65) and poplars. In the bush story scattered bspr (with vegetative reproduction) and fir. In the neighbourhood 56—60 feet high fir, responsible for the good fir reproduction. Reproduction: many fir seedlings, but no bspr seedlings. On one sq.metre of *Sphagnum* 42 fir seedlings, of these 35 seedlings 1—2 years old; on *Hylocomium*-cover only 0—1 fir seedling on each sq.metre. Older fir seedlings measured: 9 × 15y, 5 × 10y, 4 × 9y, 6 × 9y, 5 × 9y, 4 × 8y, 4 × 7y, 4 × 7y, 4 × 6y, 4 × 6y, 2 × 3y. Cryptogams: mostly feather moss incl. *Dicranum rugosum,* scattered *Cladina rangiferina* and *Peltigera* sp. Patches of *Sphagnum acutifolium.*

19. Abt. $^1/_2$ mile E of the river near Renison an old and slow growing homogeneous stand of bspr of Cornus-Vaccinium type. Sample trees: *36 × 5*, age 105, *36 × 5*, age 110, *33 × 5*, age 107, *29 × 6*, age 105, *21 × 3*, age 100. No reproduction. Dominant *Hylocomium* and *Pleurozium* with small patches of *Sphagnum squarrosum* and *S. Girgensohnii,* incl. scattered *Opisteria* cfr *arctica, Peltigera* sp. and *Cladina rangiferina.*

Table 11. Vascular plants on sample plots 17—22.

	17	18	19	20	21	22
Cornus canadensis	2	2	1	1	—	—
Ledum groenlandicum	1	1	1	1	—	—
Vaccinium Vitis-Idaea	×	×	2	—	—	—
Kalmia angustifolia	1	1	—	×	—	—
Gaultheria hispidula	×	×	—	1	1	—
Trientalis borealis	×	×	—	×	—	—
Linnaea borealis	1	—	—	—	—	1
Rubus chamaemorus	1	—	—	—	—	—
Vaccinium angustifolium	×	1	×	—	—	—
Vaccinium myrtilloides	1	—	—	—	—	—
Equisetum sylvaticum	1	—	1	—	—	—
Geocaulon lividum	×	—	×	—	—	—
Rubus pubescens	×	—	×	—	—	×
Carex disperma	×	—	—	—	—	—
Smilacina trifolia	×	—	—	—	—	—
Petasites palmatus	×	—	—	—	—	—
Equisetum pratense	—	1	—	×	×	×
Mitella nuda	—	—	—	×	—	1
Equisetum scirpoides	—	—	—	×	—	—
Lonicera involucrata	—	—	—	—	×	—
Goodyera tesselata	—	—	—	—	×	×
Pyrola minor	—	—	—	—	×	—
Moneses uniflora	—	—	—	—	—	×
Number of species (23)	16	8	7	8	5	6

20. $^1/_2$ mile W from the camp at Renison, at a brook on a bank facing NE. Feather moss forest on the edge of the bank, inside of which a bsprmuskeg begins. Trees on the sample plot: bspr: 65 × 12, *60 × 10*, age 105, bspr. *60 × 10*, age 100, bfir 48 × 6; 3 dead bspr and 3 partly decayed stumps of aspen and 3 dead aspen trees reaching 60 feet showing that this feather moss forest probably developed from a very old burn. Reproduction: 3 fir seedlings (1—3 years) per sq.metre. Two old fir seedlings: 5 × 7—8y, 4 × 7—8y. — Dominant feather moss cover of *Pleurozium*, *Hylocomium* and *Ptilium*, incl. *Dicranum rugosum*, *Ptilidium ciliare* and *Peltigera* sp.

21. About 200 m from the river (157 mileage). Mixed forest of fir and bspr with scattered wspr and dead bspr trees. No bush cover, but some dead 1—2 m high bspr bushes. One young poplar. Trees measured: wspr 42 × 8$^1/_2$, age 55, at the ground 65, wspr 39 × 6, age 65, at the ground 75, bspr 39 × 5, age 75, fir *39 × 5*, age 76, at the ground 90, fir *24 × 3*, age 70, at the ground 93. Reproduction: On one sq. metre 34 fir seedlings and an average per sq.metre of one 1—year old bspr seedling and one older wspr seedling. Satisfactory cone production. Dominant feather moss cover.

22. Luxuriant balsam fir-spruce forests near the creek 1 mile from the Renison camp. Dominant fir with wspr (sample 75×28, about 165 years old) and scattered bspr. Bush-cover: fir dominated, incl. scattered wspr- and bspr-bushes. Reproduction: 0—1 wspr seedlings (3—4 years old) per sq.metre. 5—10 fir seedlings per sq.metre. 4 bspr seedlings: 13×20y, 15×27y, 9×15y, 12×21y. Dominant feather moss (incl. *Dicranum rugosum*) cover with scattered *Cladina* sp. and *Peltigera* sp.

Mixed balsam fir — white spruce forests

The sample plots 23—24, 28—29 are from Renison, 25—27 from Moose Factory and 30—32 from Mc Innis. Nr. 30—32 represent rich fir and spruce groves of *Aster*-type with i.a. *Diervilla Lonicera, Clintonia borealis,* etc., which are rare in the lower Moss River area. Sample plot 33 is a white spruce forest of the kind which gives the best timber in the whole area, see above p. 10.

23. Near a small brook, Renison. Mixed forest of bfir (samples: *45×6,* age 75, *36×4,* age 65). poplar (sample: 60×16, age 60—70), aspen (sample: 51×9, age 70) and bspr (sample trees *42×6,* age 60, *54×10,* age 65×70). Thus a rather fast growing stand, which seems to develope into a feather moss dominated forest, but still with rich signs of the original flora of vascular plants; fir thickets 1—1.5 m high. 25—30 fir seedlings on one sq.metre, no bspr and poplar seedlings. Samples of fir seedlings: 4×13y, 4×11—12y, 3×6y, 3×8y, 3×8y. Dominant *Hylocomium, Pleurozium, Rhytidiadelphus, Ptilium,* incl. *Drepanocladus uncinatus, Brachythecium* sp., *Blepharostoma trichophyllum* and *Peltigera* sp.

24. A fir and wspr grove with poplar on a slope on the E-side of the river (mileage 154). Samples of trees: fir *54×9,* age 76—80, *51×8,* age about 80, wspr 72×9, age 84, wspr 72×10, age about 80, poplar 60×10. The bush cover consists of fir, 0.5—8 m high, and scattered other species, see Table III. No notes on cryptogams. About 10—25 bfir seedlings/sq.metre.

25. Moose Factory Island. On the N-side an about 100 years old mixed poplar-fir stand with some wspr. Samples of trees: fir *57×11,* age 80, at the ground about 100, *39×9,* age 65, at the ground 80; wspr *51×12,* age 65 at the ground 70; *27×5,* age 60, at the ground about 80. The bush cover formed by fir and 12—15 feet high alder, incl. scattered young wspr. Reproduction: on each sq.metre about 5 fir seedlings, 1—5 years old, and about 2 wspr seedlings (one of the few sample plots where young wspr seedlings found), 3—5 years old. Sample of older fir seedlings: 8×8y, 14×8y, 27×15y; also 16, 22 and 25 year old fir seedlings noted. Older wspr seedlings on the plot: 14×10y, 9×9y, 14×8y, 10×10y, 45×18y; also 15, 27, 28 and 2 years old wspr seedlings noted. Mostly *Rhytidiadalphus,* incl. *Pleurozium, Hylocomium, Drepanocladus uncinatus, Eurrhynchium pulchellum* (= *E. strigosum*), *Mnium cuspidatum, M. marginatum* (= *M. serratum*).

26. Flooded sample plot on the N-side of Moose Factory Island. Well grown wspr and fir. Wspr: *54×12, 42×14, 48×7,* fir *42×6, 30×6.* Bush cover

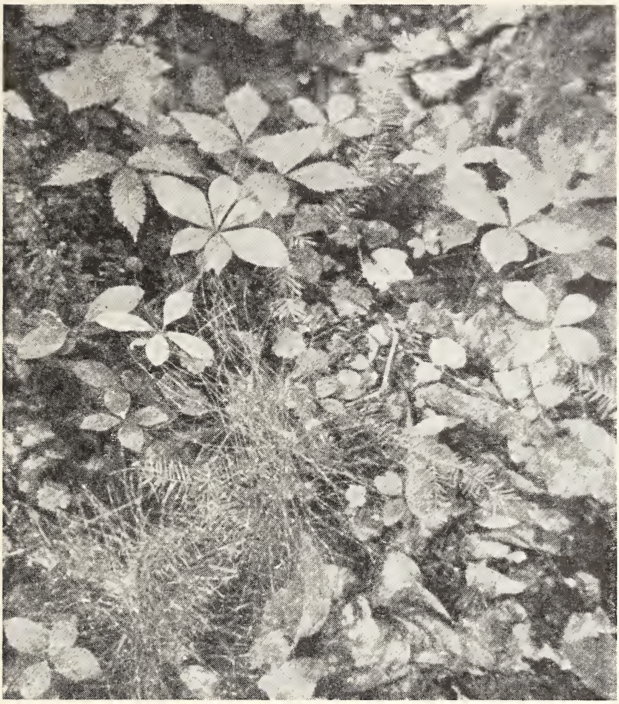

Fig. 8. Ground vegetation (i.a. Rubus pubescens, Cornus canadensis, Mitella nuda, Petasites palmatus, etc.) and balsam fir shoots in a »rich» balsam fir and white spruce forest near sample plot 28.

of fir and alder. On each sq.metre about 20 fir (mostly 2 years old) seedlings, 2 older wspr seedlings and 2—3 mountain ash seedlings. Also on the plot one 9 and one 6 year old fir seedling and vegetative reproduction of fir and alder. Mostly *Hylocomium, Pleurozium* and *Rhytidiadelphus* in the moss cover; no lichens on the floor because of the flooding.

27. $^1/_2$ mile W of the HBC station on Moose Factory Island. Mixed young fir, wspr and poplar forest. Sample trees: bfir 36 × 6, age at the ground 55; poplar 30 × 5, age 44; In the bush cover bfir, alder and mountain ash. 1—3 fir seedlings on each sq.metre, particularly, however, on old stumps. One wspr seedling, 3 years old. Vegetative reproduction of poplar. Mostly *Rhytidiadelphus;* on old stumps also *Hylocomium* and *Ptilium.*

28. A fir and wspr grove near the river (mileage 154). Dominant fir; fir *48 × 9,* age 78, 33 × 6, age 61, *54 × 14,* age 85, wspr 75 × 30; white birch 48 × 10. (Aspen and poplar nearby). In the bush cover dominant mountain maple, incl. fir and *Cornus stolonifera.* About 15 fir seedlings on each sq.metre. Cryptogams: *Rhytidiadelphus, Hylocomium, Drepanocladus uncinatus* and *Peltigera* sp.

29. 1 mile E of Moose River (1952) mixed fir — black spruce forest. One 1/40 acre 12 bspr (samples: 42 × 10, 45 × 8, 39 × 7), 5 poplars (sample 56 × 14)

and 3 firs. Humus cover about 1 foot on clayey sand. No seedlings of bspr or fir, but vegetative reproduction of both species, as also of poplar. One mountain ash seedling was the only generative seedling present on the plot. Cryptogams: Mostly *Rhytidiadelphus,* incl. *Hylocomium, Pleurozium* and *Ptilium.* Other species collected here: *Drepanocladus uncinatus, Dicranum fuscescens, Eurhynchium pulchellum* (= *E. strigosum*), *Isopterygium turfaceum, Brachythecium salebrosum, Jamesoniella* (*Jungermannia*) *autumnalis* (det. Dr. H. Buch). Epiphyte lichens: *Parmelia sulcata, Parmeliopsis hyperopta, P. ambigua* and *Evernia mesomorpha.*

30. Mc Innis. Fir grove, virgin stand, about 1/4 mile from the railway. Dominant fir: 45 × 7, age 78, 45 × 8, age 85; 42 × 10, age 120; 45 × 11, age 102; 24 × 3, age 50, and scattered poplars (42 × 3, age 48; 45 × 7, age 64; 54 × 16); most of the trees with rot. In the bush cover 12—15 feet high alder and poplar. Rich reproduction of fir as usual on such habitats: about 25 (sometimes 50 seedlings) bfir per sq.metre, mostly 5 years old. Only one wspr seedling (wspr in the neighbourhood), 5 × 7y. Humus about 2 inches deep. Cryptogams: *Hylocomium, Pleurozium, Ptilium, Rhytidiadelphus,* incl. *Dicranum rugosum, Mnium Drummondii, Brachythecium* sp.

31. Mc Innis. Wspr grove with scattered poplar and bspr on slight NW-slope near the railway. Samples of trees: wspr 51 × 10, age 117, 51 × 10, age 109, poplar 42 × 9, age 87, 45 × 9, age at least 85, bspr 30 × 5, age 52. In the bush cover alder, *Cornus stolonifera,* poplar-shoots etc. The locality rich in herbs. Cryptogams, collected among dominant herbs: *Drepanocladus uncinatus, Thuidium Philibertii, Mnium rugicum, Fegatella conica.*

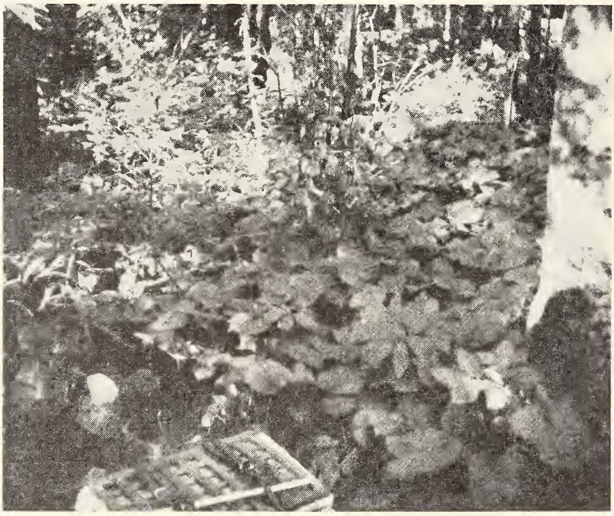

Fig. 9. Ground vegetation (mainly Aralia nudicaulis) in a luxuriant balsam fir grove near McInnis.

32. Mc Innis. Luxuriant fir grove with wspr, poplar, aspen, bspr. Sample of trees: bfir 39 × 7, age 45; 45 × 8; wspr 51 × 11, age 120—125; poplar 42 × 10, age about 110; aspen 24 × 4, age about 18. An »under-story» of 15—25 feet high fir, a 18 feet high cherry tree *(Prunus virginiana)* and a bush cover of *Alnus crispa*, *Amelanchier* sp. and aspen; a secondary low cover of bspr, etc. No notes on the reproduction. Scattered *Hylocomium* and *Pleurozium* under dominant herbs.

33. Good wspr forest about 200 m from the E shore of the Moose river (about 158 mileage) untouched by forest fires. Wspr reaches here 100 feet in height and 16—18 inches d.b.h. Sample trees: wspr *100* × *16*, age 100, *90* × *16*, age 105, *75* × *12*, age 110, *60* × *10*, age 95—100, *105* × *18*, age 109. Scattered birch, aspen, mountain maple and young fir. No wspr seedlings; older fir seedlings scattered on the sample plot, rich in herbs. Cryptogam cover: *Hylocomium*, *Rhytidiadelphus triquetrus*.

Secondary forests

This group comprises »hardwood» forests, which have grown after recent fires or cuttings. On such areas white birch, balsam poplar and aspen form rapidly growing more or less pure stands (cf. p.34).

34. Moosonee, near the shore 1 $^1/_2$ mile N of the station. Humus layer 2—4 inches on a deep more or less pure clay layer. Mostly poplar (sample trees 36 × 6, age 25—30; 33 × 6, age 45) with some wspr (36 × 6; 30 × 5, age about 30). In the bush cover alder and scattered young 9—12 feet high wspr, *Cornus stolonifera* and mountain ash (15 feet high). Few cryptogams (*Brachythecium salebrosum* collected here).

35. Moosonee, balsam poplar grove 1—1 $^1/_2$ mile N of the HBC-station. Only poplar trees (5 on 1/40 acre), all about 50—55 years old and 21—30 feet high only; up to 10 inches d.b.h. In bush cover mountain ash, vegetative shoots of poplar, 9 feet high *Cornus stolonifera*, etc. No notes on cryptogams. No reproduction, except some shoots of poplar and mountain ash.

36. Secondary forest near a dried creek in Renison (about 158 mileage). A large area burned about 25 years ago. Fast growing aspen is here the dominant tree; 42 × 6, age 25 d.b.h.; 42 × 6, age about 20. Scattered white birch (sample 27 × 3) and wspr (10 × 1, age about 20.) Some wspr stumps with signs of the burn. Scattered bush species (*Salix* sp., *Cornus stolonifera*, *Viburnum edule*) and a rich ground flora (in the neighbourhood i.a. *Clematis verticillaris*). Few poplar seedlings (no vegetative shoots) and some wspr seedlings: 18 × 13y, 11 × 10y. No notes on cryptogams.

37. Similar aspen forest, developed after a fire about 25 years ago; $^1/_2$ mile from sample plot 35. Mostly aspen (sample 33 × 5, age 14), including poplar (33 × 6, age 24) and fir (9 × 2, age 21). Here also a high bush story of alder, birch, *Cornus stolonifera*, mountain ash, *Rhamnus alnifolia*, *Salix* sp. and *Amelanchier* sp. (15 feet high, age 13). Reproduction: wspr seedlings: 8 × 8y, 9 × 5—6y, 1 × 2y, 1 $^1/_2$ × 2y, and fir: 6 × 8y. Scarce moss layer of *Hylocomium*, *Pleurozium*, *Drepanocladus uncinatus*, *Mnium rugicum*, *Hypnum* sp, *Brachythecium* sp.

Table III. The vascular flora on sample plots 23—40.

	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Cornus canadensis	1	—	1	2	1	1	1	×	—	×	—	1	1	1	—	—	1	×
Linnaea borealis	1	1	×	×	—	—	×	1	—	×	×	—	—	2	×	—	×	—
Mitella nuda	1	1	2	2	1	1	2	×	×	—	1	1	1	1	1	2	×	×
Habenaria obtusata	1	×	—	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—
Pyrola asarifolia	×	1	×	—	×	—	—	—	—	—	1	—	×	×	—	×	—	—
Dryopteris Linnaeana	×	—	—	—	×	—	—	×	—	—	×	×	—	×	—	—	—	×
Equisetum pratense	×	—	×	×	×	—	×	—	—	—	1	×	—	1	1	×	—	—
Viburnum edule	×	×	—	—	—	×	×	×	—	—	×	—	1	×	×	×	—	×
Corallorhiza trifida	×	—	—	—	(×)	—	—	×	—	—	—	—	—	—	—	—	—	—
Rubus pubescens	—	1	×	1	×	×	1	1	1	—	×	2	×	—	1	1	1	×
Equisetum arvense	—	1	—	×	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ribes ssp.	—	×	×	—	—	—	—	×	×	×	×	—	1	×	×	×	×	—
Rosa blanda	—	×	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—	—
Lonicera canadensis	—	×	—	—	—	—	—	—	—	×	—	—	—	—	—	—	—	—
Fragaria virginiana	—	×	—	—	×	—	—	—	—	—	×	—	—	—	—	×	—	—
Moneses uniflora	—	×	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—	—
Aralia nudicaulis	—	—	×	1	1	2	2	×	1	2	×	—	—	1	×	1	×	2
Mertensia paniculata	—	—	×	—	—	×	1	×	×	—	×	1	1	1	1	2	—	×
Actaea rubra	—	—	1	—	—	×	×	—	×	—	—	×	1	—	×	—	×	—
Galium triflorum	—	—	×	—	—	—	×	×	—	×	—	1	1	×	×	1	—	×
Viola pallens	—	—	×	—	—	—	—	—	—	×	×	×	—	—	—	×	—	—
Pyrola secunda	—	—	×	—	—	—	—	—	—	—	—	—	—	×	—	—	×	×
Lonicera involucrata	—	—	×	—	—	—	—	—	—	—	—	—	—	—	×	—	—	—
Trientalis borealis	—	—	—	×	—	—	1	×	×	—	—	×	—	×	—	—	1	×
Pyrola virens	—	—	—	—	—	×	—	—	—	—	—	—	—	—	—	—	—	—

Rosa acicularis	—	—	—	—	—	×	×	×	—	1	—	—	1	—	×	—	—	×
Cinna latifolia	—	—	—	—	—	—	×	—	—	—	—	×	—	—	—	—	—	—
Viola renifolia	—	—	—	—	—	—	×	×	×	—	—	—	—	(×)	—	—	—	—
Petasites palmatus	—	—	—	—	—	—	×	×	×	—	—	—	—	—	—	×	—	×
Anemone quinquefolia	—	—	—	—	—	—	×	×	—	—	—	—	—	—	×	—	—	—
Aster cfr cordifolius	—	—	—	—	—	—	—	2	2	2	—	—	—	×	—	—	—	2
Lycopodium annotinum	—	—	—	—	—	—	—	1	—	×	—	—	—	—	—	—	—	×
Maianthemum canadense	—	—	—	—	—	—	—	1	—	×	—	×	×	×	1	—	—	×
Diervilla Lonicera	—	—	—	—	—	—	—	1	1	×	—	—	—	—	—	—	—	1
Streptopus amplexifolius	—	—	—	—	—	—	—	×	—	—	—	—	—	—	—	—	—	×
Clintonia borealis	—	—	—	—	—	—	—	×	—	×	—	—	—	—	—	—	—	×
Gaultheria hispidula	—	—	—	—	—	—	—	×	—	—	—	—	—	—	—	—	—	—
Goodyera tesselata	—	—	—	—	—	—	—	×	—	—	—	—	—	—	—	—	—	—
Lycopodium clavatum	—	—	—	—	—	—	—	—	×	×	—	—	—	—	—	—	—	—
Botrychium virginianum	—	—	—	—	—	—	—	—	×	—	—	—	×	—	×	—	—	×
Vaccinium myrtilloides	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—	—	—	—
Lycopodium obscurum	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—	—	—	—
Epilobium angustifolium	—	—	—	—	—	—	—	—	—	×	—	—	—	×	—	—	—	×
Rubus strigosus	—	—	—	—	—	—	—	—	—	—	×	—	—	×	—	—	—	1
Geum rivale	—	—	—	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—
Galium boreale	—	—	—	—	—	—	—	—	—	—	—	—	×	—	—	—	—	—
Sambucus pubens	—	—	—	—	—	—	—	—	—	—	—	—	—	×	—	—	—	—
Lonicera hirsuta	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×	—	—	×
Rhamnus alnifolia	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×	—	—	—
Vicia americana	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×	—	—	—
Achillea millefolium	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×	—	—	—
Thalictrum cfr polygamum	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×	—	—	—
Pyrola minor	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×	—
Calypso bulbosa	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×	—
Coptis groenlandica	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×
Dryopteris spinulosa coll.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×
Kalmia angustifolia	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×
Calamagrostis canadensis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	×
Number of species (58)	9	12	14	8	9	11	17	24	13	17	14	12	13	19	20	12	11	26

38. 40—45 year old birch forest on W-side of the river (mileage 154). Dominant *Betula papyrifera* var. *commutata*: 42×5, age 37—38; 39×5, age 35—38; 42×6, age about 40. Scattered bfir (sample 30×4, age 35) and poplar (36×4, age about 30). In the bush cover alder, *Salix* cfr *planifolia*, 24 feet high, and *Cornus stolonifera*. 5—10 fir seedlings (1—2 years) per sq.metre; also older fir seedlings (6 and 12 years old). 5 wspr seedlings (1, 8, 9, 11 and 12 years old). Moss cover of *Rhytiadelphus*, *Hylocomium*, *Ptilium*, incl. *Dicranum rugosum*, *Drepanocladus uncinatus*, *Mnium rugicum*, *M. medium*, *M. punctatum* and *Brachythecium* sp.; also *Peltigera polydactyla*. Epiphyte lichens: *Alectoria implexa*, *A. sarmentosa* and *Lobaria pulmonaria*.

39. »Secondary» forest after irregular cutting on W-side of Moose Factory Island with young or budly grown fir, poplar, wspr, cedar, white birch and mountain ash. Samples of fir: *24×4*, age 87 at the ground 104; *36×7*, age 90 at the ground 100). Poplar reaches 36—45 feet and some wspr about 36 feet. Old wspr stumps. A typical fragmentary forest often cut for timber. 30—50 cm peat on clayey soil. In the bush cover dense thickets of vegetative shoots of fir, cedar and alder, all the result of a strong vegetative reproduction; also *Cornus stolonifera* and birch. Two fir seedlings (2 and 11 years old) and two wspr seedlings (6×8y and 8×16y). Few seedlings of alder and mountain ash, but mainly vegetative reproductions on such types of »forest». *Hylocomium splendens* still dominant in the moss floor, incl. *Pleurozium* and *Dicranum rugosum*.

40. Smoky Falls. A secondary white birch-aspen forest about 1 mile W from the village. Samples of trees: birch 36×8, aspen 48×9, incl. scattered wspr 45×8. The under story is formed by mountain maple, alder (*Alnus rugosa* and *A. crispa*), birch, *Cornus stolonifera*, mountain ash and *Amelanchier* sp. Such young secondary forests rich in bush species and herbs are common in the area.

Jack pine forests

Jack pine does not grow in the lower Moose River area but occurs in the neighbourhood in some of its northernmost localities. The two sample plots below give an idea of the good stands occurring on the ridges near Smoky Falls. There are probably similar forests near Coral Rapids.

On a well-drained ridge about 3 miles N of Smoky Falls a good young evenaged jack pine stand, developed after fire, about 36—50 feet in height and 4—8 inches in d.b.h. Trees measured: 48×8, age about 40; 42×6, 45×6 and 51×8, age about 50. Ground vegetation: *Aster* cfr *macrophyllus* 1, *Vaccinium cespitosum* 1, *Ledum groenlandicum* 1, *Pyrola* cfr *minor*+, *Solidago* cfr. *puberula*+, *Epilobium angustifolium*+, *Kalmia angustifolia*+, *Petasites palmatus*+. No reproduction of jack pine. In the cryptogam cover mainly *Pleurozium*, incl. *Ptilium*.

Good even-aged jack pine stand about 5 mile N from Smoky Falls on a well-drained sand plateau. Jack pine reaches here about 45—48 feet in height and 4—10 inches d.b.h; the stand is probably about 50 years old. Samples of trees: 51×9, 48×9, and 42×8, all well-grown. No reproduction of jack pine, but young low black spruce, ½ m. high. Scattered poplar (42×8), birch (51×8), alder and one wild cherry tree (*Prunus pensylvanica*) 15×2. Ground vegetation: *Gaultheria hispidula* 1, *Cornus canadensis* 1, *Aralia nudicaulis* 1, *Ledum groenlandicum* +, *Vaccinium angustifolium*+, *Vaccinium myrtilloides*+, *Pyrola secunda*+, *Majanthemum canadense*+, *Diervilla Lonicera*+, *Epilobium angustifolium*+, *Lycopodium annotinum*+, *Linnaea borealis* +, *Goodyera tesselata*+, dominating *Pleurozium*, incl. *Ptilium* and *Dicranum undulatum*, *Cladina mitis*.

The stand has developed after fire; the former tree generation was an astonishingly good jack pine stand, judging from fallen trees; some pines reached 87×18, i.e. the best-developed jack pine the author has seen or heard of in Canada. Also some shoots of poplar.

The ridges near Smoky Falls are good habitats for jack pine; on young jack pine the annual shoots here reach 65 cm.

Near Coral Rapids (mileage 93—94 N of Cochrane) the following note was made in 1952 in one of the northernmost jack pine stands along the railway in the area, about 30 years old; trees 21—27 feet high and 3—4 inches d.b.h. Dense stand, after a fire on a sandy patch. Ground vegetation: *Vaccinium angustifolium* 2, *Kalmia angustifolia* 2, *Cladina* cfr. *mitis* 2, *Pleurozium* 1, *Epigaea repens*+, *Vaccinium myrtilloides*+, *Pyrola* sp.+, *Solidago cfr. puberula*+.

V. Notes on the Forest Types in the Area

The sample plots represent the most typical forests in the area investigated. Using the tentative forest type system as presented earlier by the author (H 1949) as a basis, the following classification of the sample plots gives a general idea of the forests in the area:

Dry series: 1. conifer lichen forest; no sample plots.
2. conifer dwarf shrub forest; no sample plots.
3. conifer blueberry (*Vaccinium*) forest: (19).
Moist series: 4. conifer feather moss forest: 20—22.
5. conifer bunchberry (*Cornus*) forest: (18).
6. rich conifer forest: 23—33.
7. mixed groves: (34—40).
Wet series: 8. open bog forest: (7, 8), 9—11.
9. black spruce muskeg: 1—5.
10. rich swamp forest: 12—15.

Inside the different main forest types, such as rich conifer forests or mixed groves, there are different subtypes. The material, however, is too small to allow any conclusions re the importance and distribution of types like *Aralia-Mitella,* etc. It remains for further forest type exploration to discover usable units for the practical forestry. The »escarpment», which so clearly is visible in the terrain near Coral Rapids and Smoky Falls, also forms a border of importance for the forest type classification in the area S of James Bay.

The difference between the physiognomic forest type theory developed i.a. by CAJANDER (compare their application to North American conditions by ILVESSALO 1929 and KUJALA 1945) and the recently developed forest site classifications based on soil sites (mainly HILLS 1952) is in forestry practice itself of minor importance. The main point is to establish some sort of general agreement on the principles for the silviculture of a certain forest region, which, as the author has pointed out (H 1954), must be rather limited. The reason for this is that the indicator plants, incl. cryptogams, themself show changing reactions towards their habitats (cf. H 1954). Before true soil sites can be distinguished a very great deal of work has to be done using as indicators — in the first stage — more or less the same physiognomic characteristics as used by the forest type pioneers. However, a synthesis of our knowledge of soil site types and plant cover types is the natural result towards which the classifications must develop. The pioneer attempt in this field by HEIMBURGER (1934) must be recognized. A recent example of this cooperation between soil scientists and forest students is the forest classification (based on HILLS) used by BEDELL and MCLEAN in their Nipigon study (1952).

In his own work the author is content with a very simple classification, based on ocular estimations and comparative field trips in many parts of northeastern Canada. Such a simple classification, as that outlined in H 1949, dispenses with scientific apparatus, elaborate conceptions and symbols. Its only function is to give a first hand picture of the forest conditions in a hitherto unknown area, compare HARE 1950 and DRUMMOND 1952.

*

The *dry forest types* are very scarce in the area. One may find them on the sandy ridges and terraces near Coral Rapids, see p. 30 above, but in the Renison area proper they are more or less absent. The small patches of forest, where *Vaccinium Vitis-Idaea* is common, see sample plot 19, are not comparable to the *Vaccinium angustifolium*-forests farther south or in the taiga proper. The common lichen woodlands are entirely absent from this once submerged area in postglacial time.

The *feather moss forest* is by no means a clearly defined type, which as a such is useable in the forestry for practical site classification. The feather moss forest develops, as far as I can understand, from different forest types; it represents a *climax* stand.

The feather moss forest in the Moose River area is of a »richer» type than the Labrador taiga in general. The sparse remnants of an once denser vegetation of herbs are not the same species as in the moss forests in the taiga proper. It seems that a stand in the Moose River area earlier reaches its climax, i.e. the feather moss stage, whereas in the taiga eastward a feather moss forest is at least 100—150 years old.

One finds black spruce, balsam fir and white spruce feather moss forests in the area. The moss floor is usually composed of *Pleurozium Schreberi, Hylocomium splendens* and *Ptilium crista—castrensis; Rhytidiadelphus triquetrus* occurs as a typical element for the rich feather moss forests in the area. The reproduction is poor in these forests. If, however, balsam fir is prese nt, there is a satisfactory reproduction of fir seedlings[1], but no black spruceor white spruce seedlings are found in such forests regardless if these tree-species are dominant or not. Particularly white spruce is a species on retreat, whereas balsam fir is expanding.

Rich forest types (i.e. forests, usually fir and white spruce, rich in herbs and with luxuriant growth in general) occur all over the clay-belt and also in the Moose River area. They differ in many respects from the rich conifer forests in the taiga in northeastern Canada. From the point of view of forestry these »rich forests» are not at all »rich»; they are often disturbed and heterogeneous. Rotis a common feature, particularly in balsam fir ,as also the occurrence of too many tree species on a small plot. Typical vascular plants in the ground vegetation in such rich forests in the Moose River area are *Mertensia paniculata, Mitella nuda, Rubus pubescens, Equisetum pratense* with *Aralia nudicaulis* as a very common component. In the scarce moss cover *Drepanocladus, Rhytidiadelphus, Brachythecium,* etc. occur, whereas lichens are entirely absent from the ground floor. Willows do not occur in such forests. Re reproduction, see sample plot descriptions.

The best timber forests in the area, the *big white spruce stands* on small border areas near the river and on the islands in the Moose and Abitibi rivers (sample plot 33) belong to the rich conifer forests with undisturbed development. Such rich white spruce forests slowly turn, however, into more and more moss-dominated white spruce stands. But when the moss cover is disturbed by cutting or fire and the soil is opened, the vascular plants again expand on the area; the secondary forest rich in herbs is there.

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[1] Fir seedlings easily form adventitious roots in the moss cover.

The *flooded forests* (i.e. flooded by spring highwater only) on Moose Factory Island are generally of a luxuriant forest type because of the clayed mud, which comes down with the river in the spring time. The trees on such areas are often rotten. Balsam fir and poplar are common trees in such forests.

Secondary forests are a frequent sight in this area, particularly along the railroads where cutting has been made. The conifers are more or less all cut, but balsam poplar, aspen and birch are left. The forest is opened and different bush species with strong vegetative reproduction and vascular plants develope into full richness on the area. Young balsam fir is a very common under-store, particularly in richer types, and »secondary forests» are thus often balsam fir forests. Such secondary forests, often rich in species, occur all over the clay-belt and also north of the escarpment.

A similar effect is caused by forest fires. One finds »secondary» aspen, balsam poplar and white birch forests with old big stumps of white spruce. Young white spruce comes up, but more often balsam fir. The ground vegetation is very rich, compare Table III. The growth of the trees in such secondary forests is fast; 42 feet high aspen trees are only 20—25 years of breast height, which means an annual diameter growth of about 1 cm. Compare also Moss's descriptions of aspen and poplar forests in Alberta (1953b).

The *black spruce muskegs* in this area show close resemblance to those in other parts of the northern taiga studied by the author near Lake Chibougami etc. The slowly growing trees have narrow crowns, often covered with black beard lichen, se p. 19. Reproduction capacity is generally fairly good, if the usually rich vegetative propagation is included. Black spruce on muskeg shows an astonishing capacity to form adventitious roots and secondary shoots. A 2 inch thick Sphagnum cover is enough to initiate the forming of adventitious roots on sloping spruce branches. Minor thick black spruce

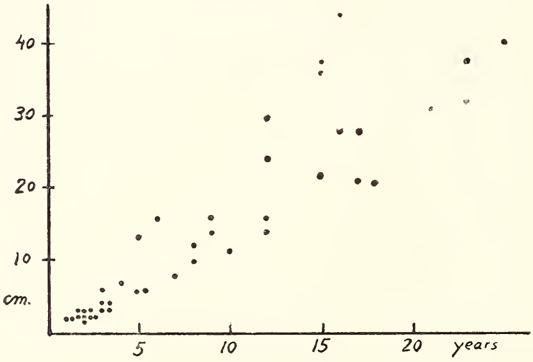

Fig. 10. Relation between age and height of black spruce seedlings on muskeg habitats in the area. Compare diagrams in H 1950 and H 1954

thickets are common around the trees on some black spruce muskeg localities. Fig. 6 shows a general muskeg tree type: they are usually slightly sloping 27—40 feet high, particularly on poorer sites, and the growth in thickness is generally very excentric; the trunk is slightly bent near the ground. This indicates that many of the trees on such forest types are earlier vegetative shoots which have slowly matured into trees. A particular feature is the very hard and »compressed» browny wood on the exposed side of the stem. Also the bark of these spruces is of different type, slightly yellow and open in flakes. Such trees are sometimes called »yellow spruce» by the lumbermen. Sometimes balsam fir intrudes into a black spruce muskeg; on such localities also the fir grows slowly and attains the shape of a »muskeg-tree».

It is of interest to compare the black spruce muskeg vegetation of lower Moose River with the notes from more northern localities. The abundance of *Kalmia angustifolia*, *Chamaedaphne calyculata*, *Smilacina trifolia* and Carices and likewise the absence of *Vaccinium uliginosum* and *Empetrum hermaphroditum* on the Moose River localities as compared, for instance, with the Great Whale River localities should be noted (cf. H 1950, H 1954).

On black spruce muskeg areas the trees sometimes appear in groups. This is also often a sign that they are primary vegetative shoots from the same main trees.

Adventitious roots are common on tamarack and black spruce on *Sphagnum*. Compare Fig. 17—18 in H 1954; similar seedlings of black spruce are as common here as in other parts of the muskeg areas. Fig. 19 in H 1954 shows the growth of Sphagnum cover and the forming of adventitious roots. This can go on for up to 18 years, maybe more; the seedlings grow only slightly faster than the annual rise of the *Sphagnum* cover. From such notes it appears that the peat grows 1/3—½ inch a year, whereas the annual shoots of the black spruce seedlings in such localities seldom exceed 1 inch. Successively the earlier annual shoots decay, the adventitious roots move higher, which makes the true age determinations of seedlings on peat bogs very uncertain. See H 1954, and Le Barron's studies of black spruce in Minnesota (1945, 1948). A good method of determining the age of spruce seedlings grown in abnormal conditions has been developed by Sirén (1950). The method can be used for »undergrown» spruces etc. on dry ground, but in peat bogs the earlier annual shoots, as pointed out above, simply decay.

Of the *Sphagnum* species *S. fuscum* and *S. acutifolium* are the dominating species. The usual absence of *Hylocomium splendens* and the rather common occurrence of *Pleurozium schreberi* is another characteristic feature in the cryptogam cover of the black spruce muskeg.

When peat moss and feather moss patches alternate on a sample plot one always finds the black spruce seedlings on the dense peat moss patches, which keep the moisture better than the feather moss patches. On burned muskegs one finds the regrowth of black spruce seedlings always on *Sphagnum* patches. Sometimes the tussocks consists of *Sphagnum*, the depressions of *Pleurozium* (sample plot 5).

The difference between a muskeg forest and a bog forest is only gradual; a black spruce muskeg is still a forest, whereas the bog forest is a bog with scattered trees.

In the Moose River area the *swamps* are partly tamarack swamps with black spruce or white spruce, partly cedar swamps. The flora consists of many different species and the types are difficult to distinguish in a small material of sample plots; see p. 19 above.

VI. Tree Growth

Growth in thickness was measured with a Swedish increment borer. The core was always taken on the south side of the tree at breast height. The annual rings were measured microscopically with an apparatus allowing a unit of 0.01 mm, compare H 1950 and H 1954. Ordinary trees on the sample plots (the trees included in the following tables are marked with *italics* in the sample plot descriptions) were selected for study. Thus, the tables below give an idea of the general growth in thickness of the trees in the area. For farther discussion of dendrochronological work and methods in northeastern Canada, compare Marr 1948 H, 1950 and H 1954.

Some general notes re the growth in thickness in the area, partly based on information from the lumbermen and peelers:

The peeling begins in the end of May (about May 25th in 1947, about May 20th 1952), when there are still snow patches in the forest. The growth activity is finished towards the end of August (about August 20th 1946 and 1947). There are many differences between different years. For instance, in 1946 the black spruce was still easy to peel two days after the cutting, in 1947 the cambial tissue was »dry» already the day after the cut. The growth starts earlier at the south side of the trunk, and earlier at the base of the trunks. It starts earlier and lasts some days later in white spruce and balsam fir than in black spruce. The ease of the peeling, the amount of sap and the time of the start of the radial growth varies, however, greatly from year to year. This is a result of the annual climatic variations. The tables below illustrate not only growth variations in general but also the oscillation of favourable and unfavourable years.

The series in Tables IV—V are means of the radial growth values (the thickness of the annual rings) of 2—5 trees. No »percentage indices» have, however, been calculated, no corrections and no smoothings have been made, except the necessary elimination of the innermost rings in the cores. Therefore the decreasing growth with increased age is still seen in the series. The material is small, but selected from representative trees in the field and carefully microscoped. Because such growth series are still very scarce from the northeastern Canadian forests the series, regardless of their insignificance from a statistical point of view, might be of interest.

In Table IV the series 1—11 represent black spruce grown on muskegs, see p. 15. As is wellknown, black spruce on such habitats grows very slowly. The fact is here, however, illustrated by real figures. In some years mature muskeg trees grow only 0.1—0.2 mm in diameter annually. The annual variations are very marked. On better forest types the growth of the spruce trees is more rapid and »safer», reaching an annual diameter growth of about 4 mm. Re growth of aspen, see p. 27.

From one year to another the radial growth increases or decreases by up to 50 %. The reason is in this area mainly the temperature as in northern areas in general (H 1948, Mikola 1950). The summer is short in the Moose River district; compare the notes on the peeling season above. Because of the irregularity and scarceness of the meteorological material[1] from the area no correlation coefficients can be calculated for the relation growth/temperature or growth/rainfall. In such poorly drained area the variations in the ground water level must have an influence on tree growth phenomena.

In general the forests in this area are young; one seldom finds trees more than 150—200 years old; this is not only according to my own limited experience but also based on information from the lumbermen. The growth series, therefore, are rather short and uncertain in earlier decades.

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[1] I gratefully appreciate the aid given in this matter by Prof. F. K. Hare.

Table IV. Black spruce growth series (0.01 mm).

Sample plot	1	2	3	4	6	7	11	17	18	19	20	23
Number of trees	2	5	3	2	2	4	3	2	3	5	2	2
1946	35	29	9	42	19	26	18	60	52	25	70	51
1945	37	30	9	35	16	22	24	92	60	26	77	74
1944	42	29	10	26	19	24	26	72	60	20	73	53
1943	32	34	10	36	23	23	22	72	66	28	67	49
1942	33	38	10	31	28	24	26	88	81	34	83	73
1941	28	32	8	29	27	26	25	94	71	29	72	75
1940	21	29	9	22	23	21	23	84	55	30	57	63
1939	20	29	8	26	26	26	18	102	56	30	52	52
1938	18	36	8	31	25	25	20	94	61	31	49	46
1937	18	35	8	32	32	31	21	85	70	39	55	68
1936	15	32	7	30	26	31	19	81	59	34	47	63
1935	15	29	7	36	36	33	21	94	77	37	55	73
1934	17	29	7	40	44	38	15	93	76	36	55	74
1933	12	26	6	38	43	33	17	95	73	34	59	78
1832	11	26	6	38	46	30	18	59	71	35	55	74
1931	10	30	8	57	51	36	15	72	73	35	59	86
1930	14	32	9	57	50	35	16	70	65	33	57	91
1929	15	23	9	34	46	25	15	98	52	27	45	77
1928	13	25	11	53	47	27	14	110	61	30	70	78
1927	13	22	13	52	45	29	13	88	55	30	61	82
1926	9	21	9	40	44	27	8	69	59	23	60	80
1925	8	23	9	44	35	32	9	72	65	25	59	70
1924	6	27	10	35	37	32	15	73	60	30	66	66
1923	7	27	12	31	28	40	18	84	59	32	57	56
1922	8	32	14	33	33	43	21	101	66	44	56	82
1921	10	36	15	28	30	36	25	88	54	40	48	50
1920	8	36	15	37	30	43	21	96	74	55	61	86
1919	11	52	20	36	36	54	26	87	70	49	61	81
1918	9	45	19	33	64	66	29	136	85	68	70	95
1917	14	40	17	35	54	61	35	132	72	52	57	85
1916	15	49	19	27	60	69	24	123	77	53	62	80
1915	14	50	19	37	64	88	24	133	79	52	72	89
1914	12	50	27	58	63	87	23	130	86	64	64	103
1913	16	67	41	63	74	84	25	143	104	73	78	136
1912	15	58	40	39	64	66	24	109	78	52	50	103
1911	16	78	40	40	73	83	22	163	92	62	60	118
1910	15	70	47	37	74	85	21	188	95	61	62	165
1909	12	66	48	40	80	83	21	180	86	64	64	138

Continued

Sample plot	1	2	3	4	6	7	11	17	18	19	20	32
Number of trees	2	5	3	2	2	4	3	2	3	5	2	2
1908	19	69	53	50	76	91	22	138	96	56	59	123
1907	16	45	43	37	54	80	22	140	80	47	63	148
1906	15	53	55	78	61	87	22	126	77	48	72	150
1905	12	75	57	77	78	104	31	138	134	54	89	168
1904	10	78	53	59	89	103	26	147	109	57	94	—
1903	10	67	56	50	92	114	26	153	102	54	86	—
1902	9	62	51	43	85	112	23	162	96	52	86	—
1901	8	58	32	38	85	115	22	200	100	48	91	—
1900	7	46	17	34	82	78	21	184	92	44	91	—
1899	6	45	13	22	81	66	18	173	102	49	109	—
1898	12	44	16	21	89	81	21	173	65	54	102	—
1897	16	45	15	20	61	72	21	103	84	51	81	—
1896	24	47	16	20	63	103	25	120	96	54	98	—
1895	22	53	20	18	60	106	22	156	102	46	90	—
1894	22	67	33	29	73	112	22	124	118	47	84	—
1893	21	61	30	30	77	89	24	100	119	46	75	—
1892	24	64	18	35	65	88	29	123	100	47	72	—
1891	22	68	32	33	80	88	25	160	90	44	71	—
1890	26	51	32	35	60	80	25	156	68	48	68	—

Table V illustrates annual variation in the growth of white spruce and balsam fir. (Increment cores from tamaracks, birch, aspen and poplar are unsuitable for dendrochronological purposes, their annual growth layers are often incomplete and indistinct and the trees are usually rotten inside, cf. H 1950 and KIRBY 1953).

Table V. White spruce and balsam fir growth series (0.01 mm).

White spruce				Balsam fir					
Sample plot	25	26	33	21	23	24	26	28	39
Number of trees	2	3	5	2	2	2	2	2	2
1946	117	99	73	100	57	80	51	149	75
1945	116	99	64	99	64	86	43	174	92
1944	142	90	59	54	40	70	43	165	110
1943	122	116	53	96	72	90	61	192	112
1942	174	142	81	123	92	90	68	232	86
1941	189	136	77	113	75	76	61	202	110
1940	156	107	69	133	75	77	56	185	80
1939	191	98	74	59	56	90	54	187	67
1938	183	99	79	97	65	77	58	180	69
1937	207	123	80	87	71	70	45	156	68
1936	190	106	76	77	45	71	42	156	55
1935	184	145	93	134	41	72	40	206	53
1934	201	101	97	42	53	59	35	184	54
1933	225	91	111	91	64	68	35	195	38
1932	213	106	111	93	53	73	35	196	42
1931	213	118	123	117	50	84	33	201	40
1930	182	105	118	140	47	85	42	225	38
1929	146	82	97	108	37	74	48	194	26
1928	142	104	107	107	45	94	68	200	38
1927	169	96	124	76	56	82	57	198	48
1926	169	119	100	65	69	68	75	208	46
1925	181	122	122	52	56	75	62	196	42
1924	156	126	102	43	66	75	83	206	46
1923	139	111	76	27	68	75	63	160	37
1922	189	126	95	48	89	93	87	247	47
1921	156	116	80	53	80	84	70	212	35
1920	148	107	96	59	76	80	68	226	38
1919	114	102	92	53	80	84	75	176	33
1918	159	127	106	67	96	97	106	220	33
1917	106	123	89	55	73	99	62	189	33
1916	117	161	122	66	92	120	78	190	33
1915	102	157	116	62	84	132	67	177	30
1914	102	176	129	82	84	139	90	211	26
1913	139	178	145	86	111	149	103	230	30
1912	87	150	110	71	89	135	87	182	19
1911	123	124	121	72	106	129	95	203	19
1910	139	133	125	102	100	128	91	212	23

	White spruce			Balsam fir					
Sample plot	25	26	33	21	23	24	26	28	39
Number of trees	2	3	5	2	2	2	2	2	2
1909	100	116	119	93	94	151	92	213	25
1908	130	123	121	75	121	157	922	40	25
1907	124	121	132	69	94	134	87	199	23
1906	132	145	141	65	110	156	96	178	31
1905	122	156	170	47	133	193	—	262	38
1904	134	—	180	62	161	190	—	260	32
1903	105	—	133	76	157	176	—	252	31
1902	149	—	135	88	163	193	—	284	37
1901	189	—	156	100	142	181	—	233	30
1900	180	—	140	149	120	176	—	225	34
1899	—	—	147	100	—	210	—	246	31
1898	—	—	128	97	—	240	—	262	29
1897	—	—	108	76	—	224	—	220	26
1896	—	—	134	72	—	253	—	249	16
1895	—	—	145	64	—	186	—	228	30
1894	—	—	157	68	—	242	—	239	23
1893	—	—	139	76	—	213	—	218	20
1892	—	—	137	76	—	217	—	226	20
1891	—	—	129	75	—	222	—	233	25
1890	—	—	103	63	—	210	—	195	17

Tables VI—VIII represent summaries of the growth series in Tables IV—V. (The series 17 and 23 are omitted because of incompleteness or exaggerated growth compared with the other series.) They are plotted in Diagram 1.

In certain years, »minimum years», the radial growth is markedly slow. Such minimum years included i. a. 1857, 1876, 1890, 1907, 1912 and 1936, which appear in nearly all series regardless of species and site. Compare Fig. 11. H 1950 and H 1954 for more detailed discussion.

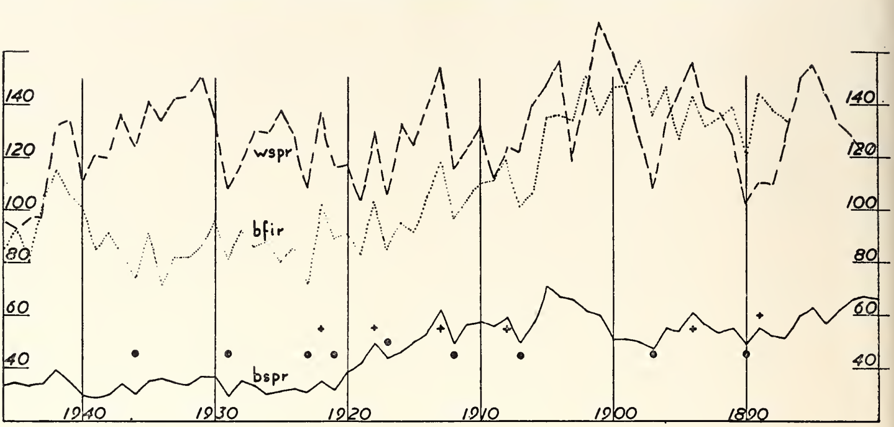

Fig. 11. A comparison between annual growth in thickness (measured in 0.01 mm) of black spruce, white spruce and balsam fir, 1880—1946, according to Tabels VI—VIII. Minimum years marked with black dots, maximum years with +.

Table VI. Radial growth of black spruce 1845—1946 (0.01 mm).

Year	0	1	2	3	4	5	6	7	8	9
1840	—	—	—	—	—	62	56	52	72	54
1850	74	81	65	68	62	70	67	51	60	64
1860	59	77	78	66	62	63	67	65	53	57
1870	56	74	65	65	61	61	56	58	66	68
1880	66	67	66	62	57	63	60	51	52	55
1890	49	55	54	57	61	54	55	47	50	51
1900	51	60	62	66	67	71	57	49	59	56
1910	57	57	49	62	53	50	46	44	49	42
1920	38	32	35	31	32	31	30	33	35	29
1930	37	37	34	34	36	35	30	34	30	29
1940	29	35	39	34	33	34	33	—	—	—

Note: Trees included in the series: 1882—1946 31 trees, 1876—1881 30 trees, 1866—75 28 trees, 1861—65 25 trees, 1854—60 16 trees, 1852—53 12 trees, 1847—51 7 trees.

Table VII. Radial growth of white spruce 1867—1946 (0.01 mm).

Year	0	1	2	3	4	5	6	7	8	9
1860	—	—	—	—	—	—	—	243	214	191
1870	149	218	188	193	189	165	140	160	142	148
1880	126	121	128	133	144	155	150	129	110	111
1890	103	129	137	139	157	145	134	108	128	147
1900	160	172	142	119	151	147	140	122	124	112
1910	132	123	116	154	139	125	133	106	131	103
1920	117	117	137	109	128	138	129	130	118	108
1930	135	151	143	142	133	141	124	137	120	121
1940	111	134	132	97	97	93	96	—	—	—

Note: 1905—1946 10 trees, 1901—1904 7 trees, 1866—1900 5 trees.

Table VIII. Radial growth of balsam fir 1887—1946 (0.01 mm).

Year	0	1	2	3	4	5	6	7	8	9
1880	—	—	—	—	—	—	—	135	138	144
1890	121	139	135	132	143	127	147	136	157	147
1900	146	136	151	134	136	135	106	101	119	111
1910	110	104	97	118	105	92	95	85	103	83
1920	91	89	102	72	86	80	88	86	92	81
1930	96	87	82	82	71	91	74	83	91	85
1940	101	106	115	104	80	93	85	—	—	—

Note: 1906—1946 12 trees, 1887—1905 8 trees.

Appendix

Vascular Plants in the Moose River (Renison) Area

The list below comprises vascular plants found by the author in the Renison area, see p. 3 re data[1]. Names according to *Gray's Manual* 8th edit. with a few exceptions. The bulk of the plants were properly collected and are kept in the Botanical Museum Herbarium in Helsingfors A duplicate set of most plants was given to the National Museum of Canada in Ottawa. For details compare FAGERSTRÖM (1949). Names with a (f)-signum according to field notes only. Some of the Renison- specimens in Ottawa have later been revised by different specialists (see foot-notes below). A careful checking of my Renison-sheets in Ottawa was kindly made in February 1954 by Mr. W. K. W. BALDWIN. Some species, found during excursions in 1952 in the Renison area, see p. 3, are added to the list (determined by Mr. MARCEL RAYMOND).

The list comprises 301 species. The water plants and the anthropochores (around the lumber camps) were unfortunately neglected. Some plants from Moosonee and Mc Innis are included in brackets. The 111 vascular plants mentioned in the text above are marked with an asterisk.

The Renison area is rather small, but its flora is unusually rich — if we remember the (climatically) northern situation of the area.

There are no collection earlier from this particular area, but from the mouth of Moose River there are many earlier collections. Travellers northward had usually to wait in Moose Factory or in Moosonee for transport and they often collected plants during these forced stays. However, POTTER (1934) was the first who more carefully studied the flora in the area south of James Bay. His list comprises 116 plants from the Moose River section, his list from the southern James Bay area contains altogether 340 species

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[1] Compare p 14 — 15. I gratefully appreciate the aid given by Dr. RISTO TUOMIKOSKI in August 1947.

It is of interest to compare this Renison-list with i.a. the collection from the Harricanaw River made by Dutilly and Lepage (1952): the similarities are marked. For discussion of phytogeographical problems in the Moose River area compare i.a. Potter 1932.

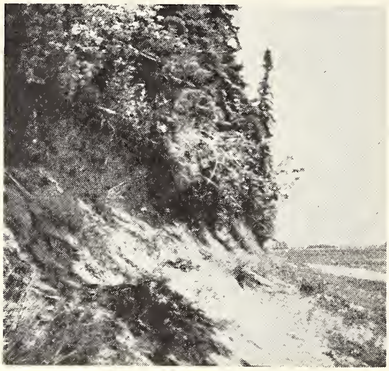

Fig. 12. Western shore of Moose River near Renison. On the banks i.a. Elaeagnus commutata, on the slopes a rich calciphile flora, compare the plant list.

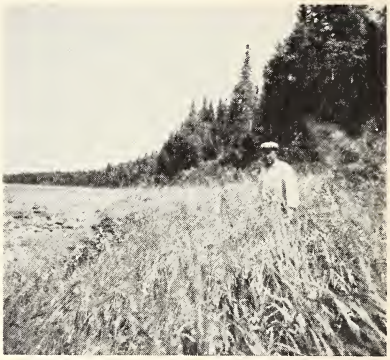

Fig. 13. Eastern shore of Moose River, 1—2 miles from Renison. In the foreground luxuriant Spartina pectinata.

* Equisetum arvense
* E. pratense
* E. sylvaticum
E. palustre
E. fluviatile (f)
E. variegatum
* E. scirpoides (f)
* Lycopodium annotinum (f)
* L. clavatum (f)
* L. obscurum v. dendroideum (f)
* Botrychium virginianum
* Dryopteris cristata
* D. Linnaeana (f)
D. spinulosa
* Picea mariana (f)
* P. glauca (f)
* Abies balsamea (f)
(Pinus Banksiana, see p. 30)
* Larix laricina (f)
* Thuja occidentalis (f)

(Juniperus communis, see p. 11)
Sparganium angustifolium
P. pectinatus
Potamogeton Friesii
P. Richardsonii
Triglochin maritima
T. palustris
Alisma triviale (f)
Sagittaria latifolia
Bromus ciliatus v. intonsus
Schizachne purpurascens (f)
Festuca rubra
Glyceria striata
G. grandis
Poa pratensis coll. (f)
P. nemoralis
P. palustris
Agropyron trachycaulum v. novae-angliae
A. trachycaulum v. glaucum

A. repens
Hordeum jubatum (Moosonee)
Elymus virginicus
E. canadensis
Sphenopholis intermedia[1]
Trisetum spicatum (f)
T. melicoides
Deschampsia flexuosa
D. caespitosa v. glauca
Calamagrostis canadensis
C. inexpansa v. brevior
C. neglecta
Agrostis alba
A. scabra
* Cinna latifolia
Muhlenbergia Richardsonis
M. glomerata v. cinnoides[2]
Spartina pectinata
Beckmannia syzigachne
Hierochloë odorata
Eleocharis acicularis
E. calva
Scirpus americanus
S. validus v. creber
S. atrovirens v. georgianus
S. hudsonianus (?)
Eriophorum opacum (?)
* E. spissum
E. viridicarinatum
* Carex gynocrates
* C. chordorrhiza
* C. disperma
* C. trisperma
C. tenuiflora
C. canescens
* C. pauciflora
* C. angustior
C. tribuloides
* C. leptalea
C. eburnea
C. aurea
C. aquatilis (incl. v. altior)
C. Haydenii
C. limosa
* C. paupercula
C. lanuginosa
C. capillaris v. major
C. flava
C. viridula
C. retrorsa
C. rostrata (f)
Calla palustris
Juncus bufonius
J. bufonius v. halophilus[3]
J. tenuis
J. filiformis
J. balticus v. littoralis
J. longistylis
J. nodosus
Tofieldia glutinosa
Allium schoenoprasum v. sibiricum
Lilium philadelphicum
* Smilacina trifolia
* Clintonia borealis (Mc Innis)
* Maianthemum canadense (f)
Trillium undulatum
* Streptopus amplexifolius
Sisyrinchium montanum v. crebrum
Cypripedium calceolus v. parviflorum
Habenaria dilatata
* H. obtusata
H. psycodes
* Spiranthes Romanzoffiana
Goodyera repens v. ophioides
* G. tesselata
Listera auriculata
L. borealis
* Corallorhiza trifida
* Calypso bulbosa
Salix lucida
S. interior

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[1] S. pallens in FAGERSTRÖM, l.c.; rev. by A. E. PORSILD, specimen in Nat. Herb. Canada.

[2] M. racemosa in FAGERSTRÖM l.c.; rev. by G. DORÉ; specimen. in Nat. Herb. Canada.

[3] J. ranarius, cf. FAGERSTRÖM (l.c.).

* S. cordata v. abrasa
* S. adenophylla
* S. myrtillifolia
S. bebbiana
* S. pedicellaris v. hypoglauca
* Populus balsamifera[1] (f)
* P. tremuloides (f)
* Betula papyrifera v. cordifolia
* B. papyrifera v. commutata
* B. minor
* B. glandulosa
* B. pumila v. glandulifera
* Alnus rugosa v. americana
* A. crispa (see p. 10)
Urtica gracilis (f)
* Geocaulon lividum
Polygonum viviparum
P. amphibium v. stipulaceum[2]
P. lapathifolium
Stellaria palustris
S. longifolia
S. calycantha
Arenaria lateriflora (f)
Ranunculus Gmelini v. Hookeri
* R. lapponicus
R. abortivus
R. pensylvanicus
R. repens[3]
Thalictrum dioicum
* T. polygamum (incl. v. hebecarpum)
Anemone multifida
A. virginiana
A. canadensis
* A. quinquefolia
* Clematis verticillaris
* Caltha palustris
* Actaea rubra
Erysimum cheiranthoides
Rorippa islandica (f)
* Coptis groenlandica (f)
Cardamine pensylvanica (f)
* Drosera rotundifolia (f)
* Mitella nuda
Parnassia palustris
* P. caroliniana Michx.
Ribes hirtellum (?)
R. oxyacanthoides (?)
* R. lacustre (McInnis)
* R. glandulosum
R. triste (incl. v. albinervum)
R. hudsonianum
R. americanum
Physocarpus opulifolius
* Pyrus (Sorbus) americana
Spiraea latifolia (f)
Amelanchier sanguinea
A. Bartramiana
* Fragaria virginiana
Potentilla fruticosa
P. norvegica
P. anserina
Geum aleppicum v. strictum (Moosonee)
* G. rivale
* Rubus chamaemorus
* R. pubescens
* R. idaeus v. strigosus
* Rosa acicularis
* R. blanda
* Prunus virginiana (McInnis)
Oxytropis johannensis
Hedysarum alpinum v. americanum
Vicia cracca
V. americana
Lathyrus palustris v. pilosus
L. ochroleucus
Impatiens biflora
* Rhamnus alnifolia
Viola nephrophylla
* V. pallens
V. incognita
* V. renifolia
* Elaeagnus commutata
Circaea alpina (Moosonee)

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[1] v. Michauxi noted by Potter (1934)

[2] cf. Fagerström, l.c.

[3] = R. septentrionalis according to W. K. W. Baldwin (comm. in letter).

* Epilobium angustifolium
E. palustre
E. glandulosum
Oenothera parviflora
Myriophyllum exalbescens
Hippuris vulgaris
* Aralia nudicaulis
Sanicula marilandica
* Cicuta mackenziana[1]
Sium suave
* Heracleum maximum
* Cornus canadensis (f)
* C. stolonifera (f)
* Empetrum hermaphroditum
* Pyrola secunda v. obtusata
* P. minor (f)
* P. virens
* P. asarifolia (incl. v. purpurea)
* Moneses uniflora
Chimaphila umbellata (f)
* Kalmia angustifolia
* K. polifolia (f)
* Chamaedaphne calyculata
* Andromeda glaucophylla (f)
* Gaultheria hispidula (f)
* Ledum groenlandicum (f)
* Vaccinium myrtilloides
* V. angustifolium (f)
* V. Vitis-Idaea v. minus
* V. Oxycoccos
Primula mistassinica
Lysimachia ciliata
* Trientalis borealis
Gentiana crinita
G. gaspensis[2]
G. amarella
G. rubricaulis[3]
Halenia deflexa
* Acer spicatum
Apocynum cannabinum
Convolvulus sepium
* Mertensia paniculata
Scutellaria lateriflora
S. epilobiifolia
Prunella vulgaris
Stachys palustris
Lycopus americanus
Mentha arvensis v. villosa
Chelone glabra (Moosonee)
Mimulus ringens
Castilleja septentrionalis
Euphrasia disjuncta
E. canadensis
Rhinanthus Christa-galli
Pedicularis groenlandica
Utricularia vulgaris
* Pinguicula vulgaris
Plantago major v. Pilgeri.
* Galium triflorum
* G. boreale
G. asprellum
* Lonicera involucrata
* L. canadensis (f)
* L. hirsuta
* L. villosa (McInnis)
* Linnaea borealis
* Viburnum edule
* Sambucus pubens
Campanula aparinoides
Lobelia Kalmii
Eupatorium maculatum
Solidago hispida
S. juncea
S. rugosa
S. lepida
S. graminifolia v. Nuttallii
Aster cordifolius
A. novae-angliae[4]
A. junciformis
A. umbellatus

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[1] According to W. K. W. Baldwin (comm. in letter) the Renison-specimen is Cicuta mackenziana.

[2] Renison-specimen (= N:o 24) revised by Frére Louis-Marie (= G. Macounii Holm in Fagerström l.c.). Re Gentianae cf. Raymond 1950.

[3] = G. lanceolata in Fagerström, l.c.

[4] = Aster modestus

Erigeron philadelphicus
E. strigosus
Antennaria pulcherrima
Bidens cernua (f)
Chrysanthemum leucanthemum (f)
* Achillea millefolium (borealis)
Tanacetum huronense
* Petasites palmatus
P. palmatus × sagittatus (det. MR)
P. vitifolius
Arnica rhizomata[1]
Senecio pauperculus
S. indecorus
S. aureus
Cirsium muticum (McInnis)
* Taraxacum officinale coll. (f)
Lactuca spicata (McInnis)
Prenanthes racemosa
P. alba
Hieracium canadense

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[1] = A. Chamissonis ssp. foliosa.

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ACTA GEOGRAPHICA 13 N:o 3

A FINNISH SETTLEMENT IN CENTRAL MINNESOTA

BY

W. R. MEAD

HELSINKI 1954

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A Finnish Settlement in Central Minnesota[1]

In North America the frontier of settlement is frequently near enough in space to be a reality: where the land is completely occupied the occupation is frequently near enough in time to be within the memory of man. In southern Minnesota, there is a tract of land across which the frontier of settlement passed a century ago: within it there exists a small colony of Finnish origin which shared in the final transformation of the natural landscape. The process in Meeker and Wright Counties has just passed beyond the memory of man.

The objects of this essay are simply (1.) to recreate the geography of the area into which a group of emigrant Finns came and (2.) to appraise the materials available for this task. The area is largely restricted to four townships: Dassel (formerly and perhaps more appropriately for Finns, known as Swan Lake), Kingston, Cokato and French Lake. As shown in Figure 1, their persistent and distinct Finnish community is detached from other Finnish settlement in this »Nordic» state. It is removed from the »podsolic soils» with which Finnish colonies in the New World have been popularly associated and it has been so completely neglected in the general picture of Mid-Western Finns that it merits rescue from obscurity.

A century ago, the tract lay on the edge of the so-called »Big Woods», recently removed from Sioux ownership, just open to land claimants and still subject to predatory Indian raids. Meeker County became an organised unit in 1856 with the introduction of the township and range framework of administration. The primary documents for an appreciation of the territory as a settlement area are the Land Surveyor's records. Minnesota was opened up largely upon the basis of the rectangular survey by which the public lands of the U.S.A. were divided by a system of lines conforming to cardinal points.

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[1] In the preparation of this paper, I am grateful to members of the County Surveyor's Office, Litchfield, Minnesota, for making available to me the materials of the original survey, to the Historical Society of Minnesota, St. Paul, for the loan of the primary census material of the state and for copies of the press from Meeker County for the middle of the last century, and to a number of farmers of Finnish origin in the area who extended their hospitality to me. Mr. JOHN BRYANT of University College, London, has kindly drawn the maps.

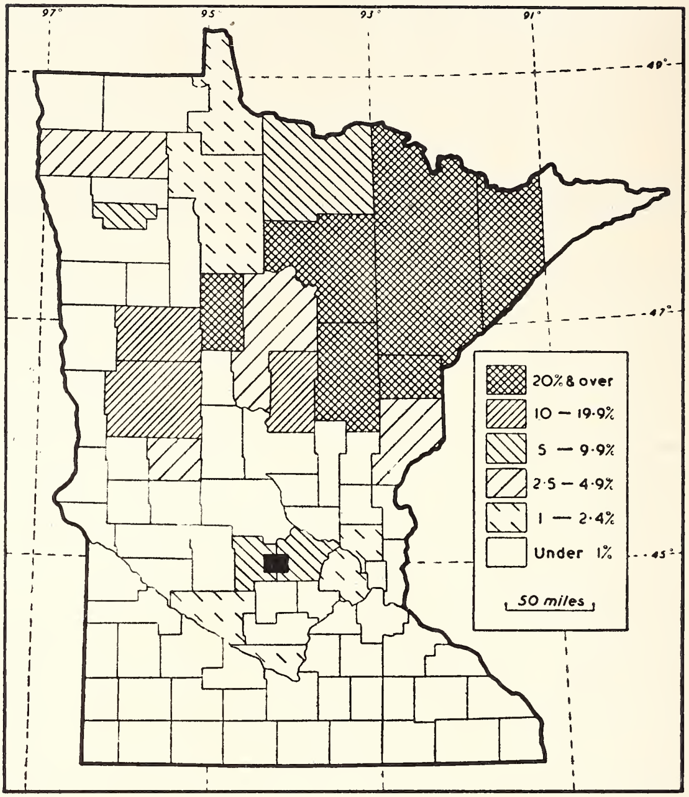

Fig. 1. The distribution of Finnish-born population as a percentage of foreign-born white population of Minnesota. The black area shows the location of the four townships.

The principal lines in this system have been the meridian, the base, the township, the range and the section: the resulting land units are the township (6 miles square), the section (640 acres) and the lot (usually a quarter section). Range lines, running north-south, divide the townships. In the surveyors' notebooks for Meeker County, [1] the tradition established by THOMAS HUTCHING in Ohio in 1786 was continued. Trained woodesmen generally accompanied the surveyors and described the character of the dominant vegetation at the

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[1] During the 1930's, the Works Project Association sponsored inventories of the county archives of many American states — among them of the counties of Minnesota. Base material for the appreciation of Meeker county is recorded in this inventory.

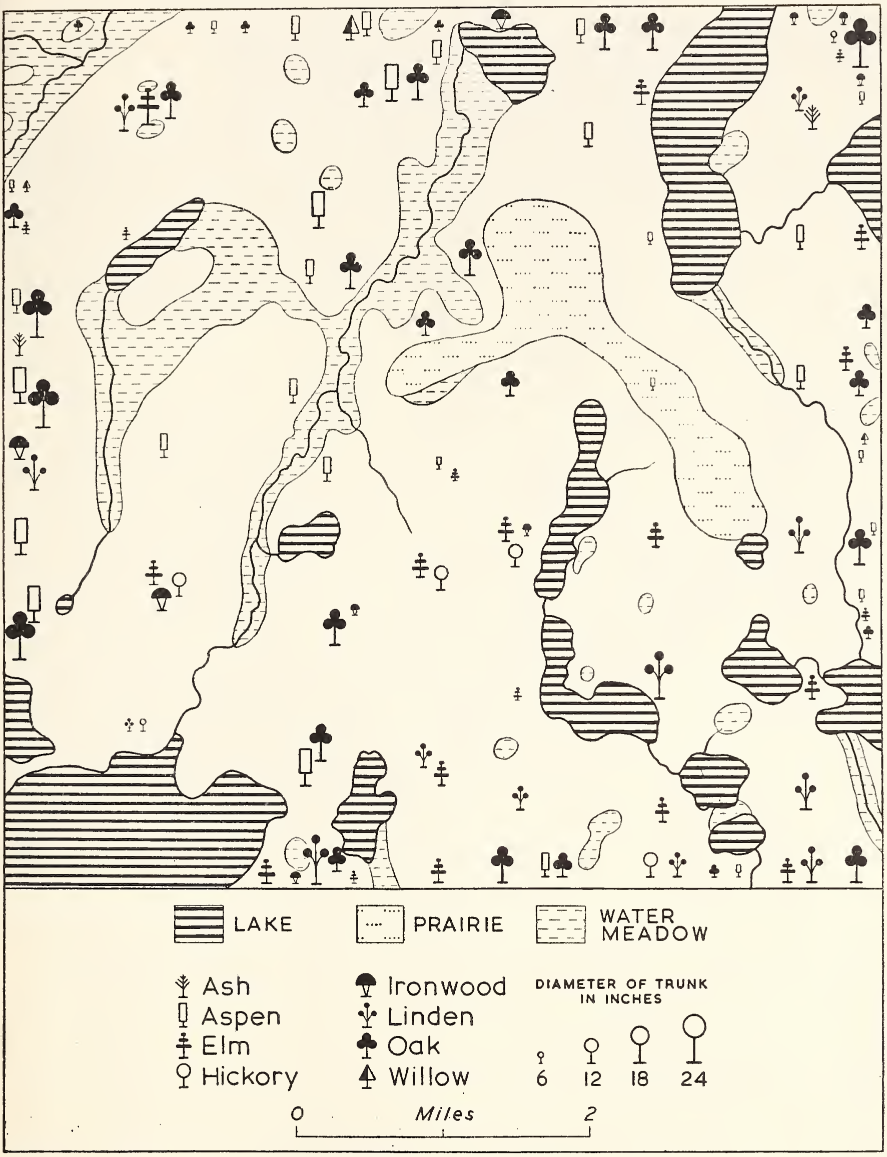

Fig. 2. Original vegetation of Dassel Township reconstructed from the Surveyor General's notes.

points of intersection of all meridians and parallels. Thus, for the townships of Meeker County it is possible to obtain a cross-section of the density and

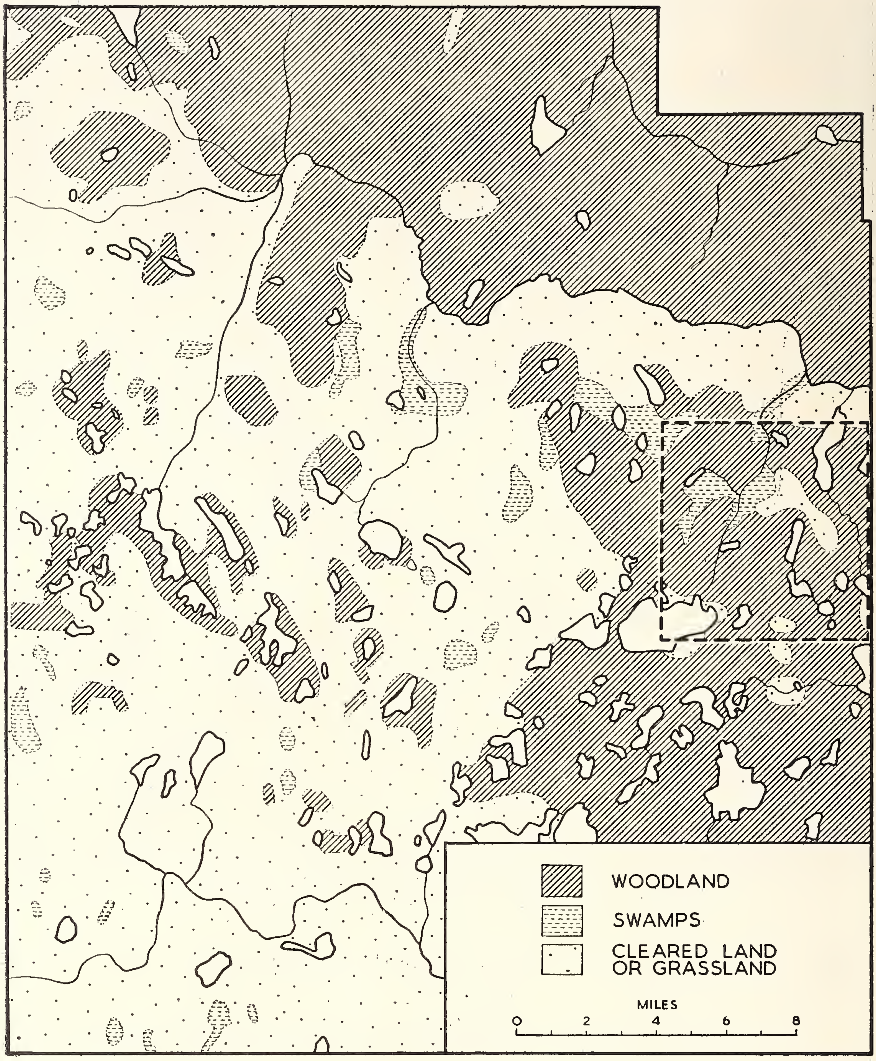

Fig. 3. Vegetation of Meeker County (after W. Andreas, *Atlas*, Chicago, 1873). The township of Dassel is inset.

size of the predominant timber, together with its undergrowth for a considerable range of intervals. Where timber is absent, grassland or bogland conditions are noted. Coupled with these are the general topographical and sometimes pedological observations of the surveyors.

Modest attempts to interpret the forester's notes were made a generation ago for Ohio by P. B. SEARS[2]), while an ambitious project to reconstruct the picture of original vegetation for the State of Wisconsin was undertaken by J. SCHAFER.[3]) Figure 2 restores diagrammatically the picture of vegetation for one of the areas of Finnish settlement — Township 119, Range 29, by name Dassel. Here, traverse information is recorded down to the corners of the »interior section». The preliminary survey was by A. H. RUNYON 34 years before the completed document was deposited in the surveyor general's office in October 1889. In the reconstructed picture an attempt is made to show the size and variety of trees prevailing in this »parkland» tract. Deciduous species were absolutely dominant. To-day, of course, they are largely cleared so that even the traditional wood lot is missing from most Finnish-American farmsteads in the area. There has, of course, been some planting of windbreaks and groves or avenues for ornamental purposes. The surveys do not concern themselves with the representation of relief so that no contouring is possible in Figure 2. The land in question, however, lies an average height of 1,000 ft. above sea level. The largest scale of available topographical maps is 1: 62,500, though these may be supplemented (in America) by air photographs commissioned by the local or central agricultural authorities.

A second source for the appreciation of primary vegetation is the map given in *Meeker County Atlas* (1873). County Atlases were becoming a popular feature of American rural bookshelves in the latter half of the nineteenth century and they have now become historical documents in their own right. Composite state atlases were also planned and Figure 3 is redrawn from W. ANDREAS's *Illustrated Historical Atlas of the State of Minnesota* (Chicago, 1873). It shows the broader vegetational distribution within the county and the location of Figure 2 is outlined on it.

The fundamental changes brought about in the natural scene of this country by immigrant settlers took place within less than two generations. Details of land occupation are obtainable from the plat books which are kept in the County Office. From the Abstract of Lots for Real Estate, kept since 1858, and in which instruments of land acquisition are recorded, it would be possible to work out the changing picture of land ownership for any community (e.g. Finnish immigrants). As an example of such an instrument, it may be quoted that on December 2, 1876, a deed was filed recording the acquisition by J. Salo of 40 acres of land in section 13, township 119 (Dassel), range 29.

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[2]) The Natural Vegetation of Ohio, *Ohio Journal of Science*, 25, 1925, 139—149: 26, 1926, 128—146: 213—231.

[3]) Four Wisconsin Counties, Prairie and Forest. Madison, 1927.

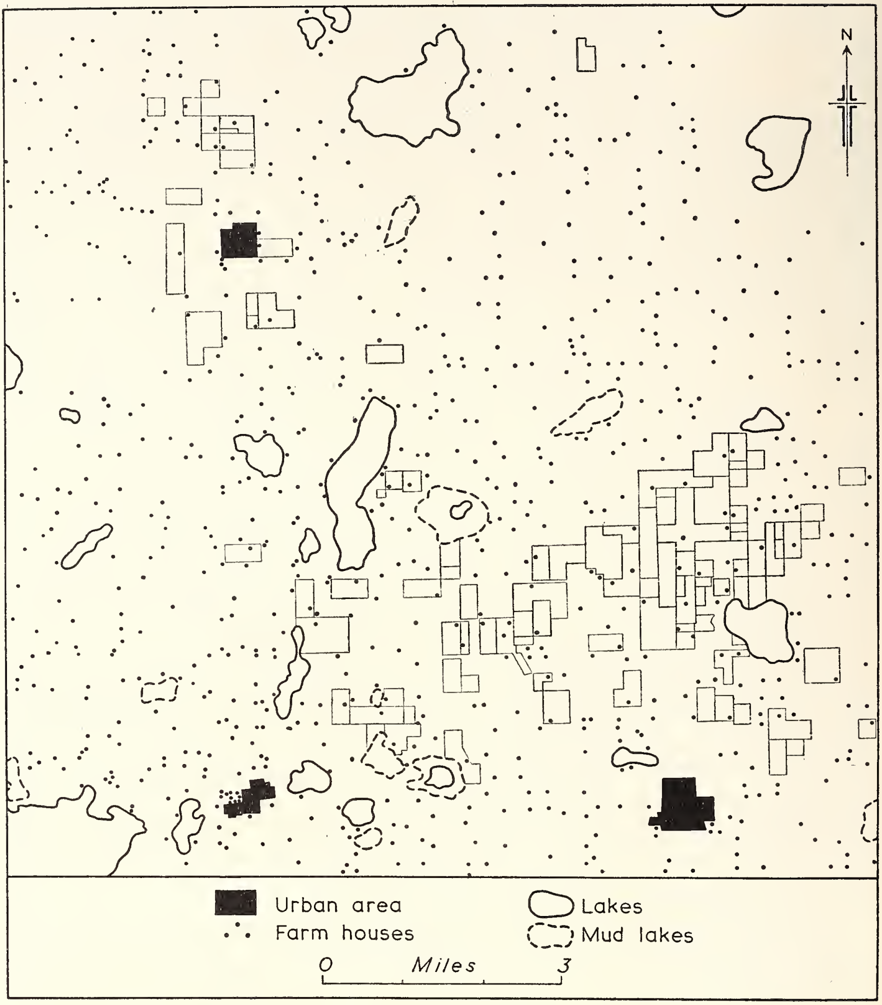

Fig. 4. Distribution of Finnish-owned land holdings in the four townships in 1897. The outlines of the holdings appear as parallelograms.

The nature of colonisation produced an area of owner-farmers. In order to give some idea of the expansion of land ownership by Finnish settlers, the material from two successive plat books of the four townships named above has been reconstructed. Figure 4 derives from the 1897 plat book of the townships and shows two features: — (1.) the location of the farmsteads — a fine example of dispersed settlement (2.) the distribution of Finnish settlers and

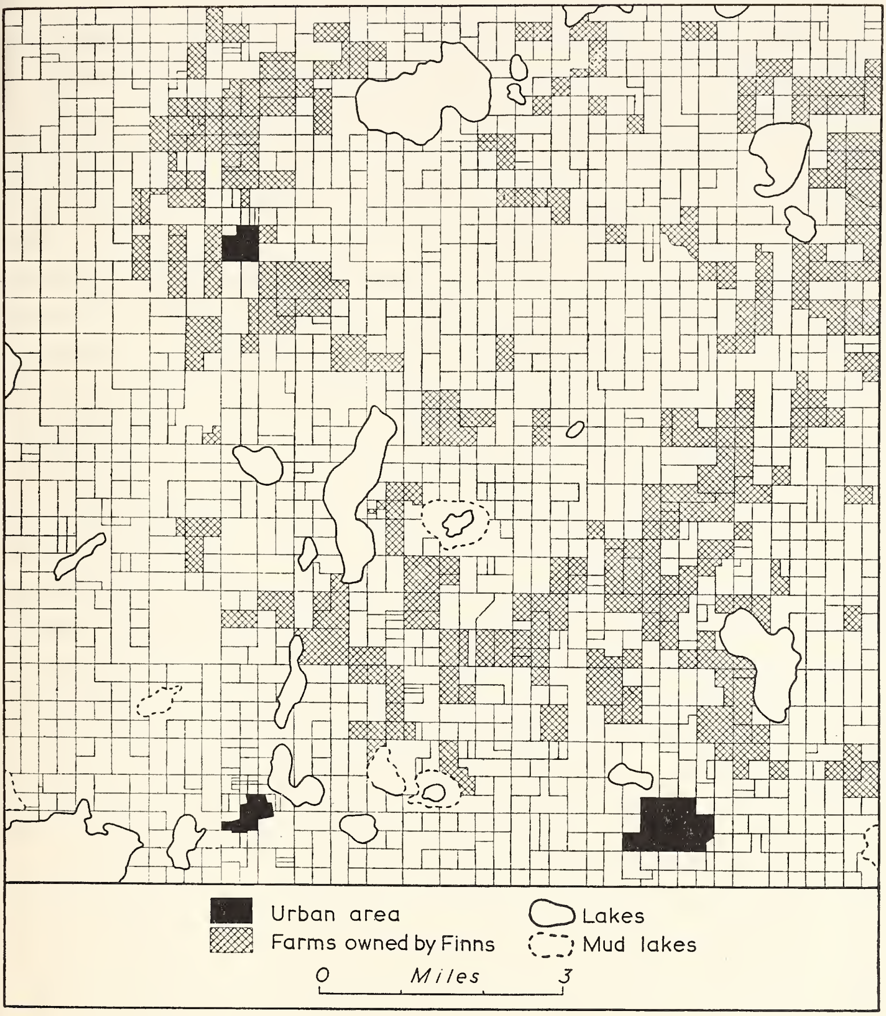

Fig. 5. Distribution of Finnish-owned land holdings in the four townships c. 1920. The outlines of all land holdings are defined.

their farm properties within the area. Figure 5 gives the detail of land ownership of a second plat from twenty years later and includes the area of farms owned by Finnish settlers. The extension of Finnish-owned farm land suggests acquisition by purchase between the two dates.

The arrival of Finns in central Minnesota paralleled that of the Scandinavians at large. They probably entered by way of the Mississippi river, travelling upstream and eventually striking cross-country by tributary routes. The settlement area in Meeker and Wright counties is only about eighty kilometres from the »mother of rivers». The earliest recorded arrivals seem to have been after 1870, for the *Statistics of Minnesota* prepared by Mr. PUSEY in that year make no mention of Finns. There may well have been a concealed immigration in the 1860's, for one of the primary problems of accounting for Finnish nationals is the »race» under which they are entered. They were initially classed as Russians (»The Russian Finns have begun to come to America», wrote a reporter in a Chicago newspaper). They might have been defined as Scandinavians or Norwegians if they derived from that community which emigrated from Hammerfest or Vadsö in the famine years of the mid-'sixties. By 1875, the instructions accompanying the State of Minnesota census forms instructed its recorders »to say that a man is a native of Denmark, Norway or Sweden rather than Scandinavia». Of the censuses which cover the peopling of Meeker and Wright counties and in particular its Finns, two are of outstanding importance. They are those of 1885 and 1895, for the 1875 census offers but a meagre harvest of Finnish names. In the 1885 census, Finns are recognised as a separate »racial» group for purposes of classification. By the 1895 census, an occupational classification was instituted and residence details were demanded. Birthplace details are not given in the census. The recorders listed the age of husband and wife and the number of children. The 1885 census for Dassel records seventeen Finnish settlements: that for 1895, 31. The age-range of adult male settlers in 1885 was from 27—60: that of females, from 22—61. Corresponding figures for 1895 were from 25—66 for men: 23—74 for women. Occupational statistics showed that with four exceptions (and they were farm labourers) all Finnish immigrants in Dassel were farmers in 1895. Ten years later, craftsmen such as a stone-mason and carpenter entered the list: together with a clergyman in adjacent Kingston township, who was supported by the Finnish community (Suomi synod still retains a pastor in this community). Of the names recorded, only one was distinctly Swedish in the 1885 census: eleven in the 1895 census. Of Finns resident in Dassel in 1895, eighteen had been resident there for less than ten years, none for more than fifteen years. At the same time, six of the eighteen had been resident in Minnesota for more than ten years: while two of the older inhabitants had been resident in the state for 24 and 29 years. The picture of settlement in 1895, so far as the Finns were concerned was therefore one of appreciable maturity. They represented an established agricultural element who were probably mobile in their earlier years as American immigrants. The birth certificates of the successive children in their modestly sized families might be a means of tracing this mobility. Once they acquired a satisfactory homestead, however, they stuck to it. They were retentive of their own names; though occasionally there is evidence of a change e.g. from Mäki to Hill or Lumi to Snow. They were frequently retentive of their own language and occasionally the censal officer noted »could not understand». By the time the main tide of Finnish migration was flowing to the States, the southern parklands of Minnesota had been fully claimed and settlement was directed northwards.¹) Even by the time Finnish immigrants reached Meeker and Wright counties the more favourably located lots and the best agricultural lands had been claimed. In a limited way, it could even be said of the Finn in this area — Suomalaisen henkeä on myös erämaahenki. Since the original settlement, however, changes in fortune have occasioned shifts in ownership so that the Finns have often exchanged second rate for first rate holdings.

There is a more loquacious source which supplements the laconic comments of the primary surveyors. *Meeker County News* and *Litchfield News Ledger* both offer descriptive material. »Prior to 1855», the *News Ledger* was writing eighty years ago, the land was occupied by »those denizens of the forest known as Sioux indians»; but »few will be the encircling years before these countries will teem with the richest gifts of Ceres». The land in its natural state was half in grass, half in hardwoods — »a pleasing picture of prairie and woodland». »Charming groves» hid a generous scatter of lakes. Running his survey line through Dassel and Kingston in 1855, A. H. RUNYON described »the surface of this line rolling. Soil first rate quality. Timber — elm, ash, oak, linden and a scattering of aspen. Undergrowth — ash and ironwood». »Natural meadows furnish an abundance of hay», wrote a *News Ledger* reporter, »and during summer cattle fatten on the rich juicy grass of the prairies». In the late fall, we read of »the woodman's axe sounding» to hew logs for »house-raising». Climatologically, the area presented contrasts. The so-called »Italianate character» of Meeker county — its air »the elixir of life» — was sometimes blasted by a succession of blizzards or contrasting »winter droughts» which occasioned prayers for snow. Mud made roads impassable at the equinoxes. Hailstorms were already being discounted by insurance agencies by the time the Finns moved in. Tornadoes, which »rocked houses like cradles» were an accepted phenomenon. It was a common report of the dry summer that »fires have been raging in the big woods» — engulfing crops, grass, livestock and property. Among other problems which disturbed the settler was the grass-

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¹) cf. D. H. DAVIS, The Finland Community, Minnesota, *Geographical Review*, 25 (1935), 382—394.

hopper. Deep-ploughing or springtime prairie-burning were advocated as remedies. In June, 1875, five dollars a bushell were offered by Meeker County Court for dead and delivered grasshoppers. Worms and mosquitoes were other afflications. Bears intruded from time to time, while deer provided excellent meat for stalking if their depredations upon sown (and rarely fenced) land could be tolerated. Wolf bounty records were still kept sixty years ago: musquash were still available for trapping. Labour, of course, was insufficient for the land: »Hands very scarce» was a regular report. The settler could not expect hired labour. He had to be a man of all trades: his wife a maid of all work. Local stability was also disturbed by »the Great Beyond». »Every day the prairie schooners pass through the town. The tide of emigration this year is very heavy», wrote the editor of the *News Ledger* in 1871. Gold fever in the Black Hills of Dakota also drained away adventurers. And the power of the trusts replaced the fear of the Indians. Dassel farmers were urged »to rise up in a mass» and »take a grip upon the railroads and wheat monopolies».

In 1870, Mr. PENNOCK PUSEY, assistant secretary of state, had collected the agricultural statistics of Minnesota and the *News Ledger* reproduced a sample of these for Meeker county. The county, which had been organised on paper and turned its first sod in 1856, had 10,805 acres of cultivated land in 1870. Wheat, oats, and potatoes, in that order, were the chief crops. Cattle dominated the stock picture — with 1800 milk cows, 1500 working oxen and 2800 others. The »market prices» of the *News* listed the following commodities: —wheat, flour, oats, corn, feed, rye meal, oat meal, bran, millings, eggs, butter, potatoes, onions, honey, beans, cheese, hay, wool and meats. Harvesters and binders were already widely advertised in the 1870's; together with fire engines and anti-freezing pumps (both of which were important in the farm picture). »Strayed or stolen» cattle notices recall the days before barbed wire control (and *Stray Notice Books* are included in Meeker County archives). Page after page of tax delinquent lands are recorded. Taxes were required by the local authorities for a variety of purposes. Thus, drainage was part and parcel of land reclamation. Ditch plat books were prepared from 1876 onwards and ditch taxes eventually demanded.¹) Finnish names rarely appeared in the tax delinquent lists and of Kingston township, it was possible to say in addition, »most farms are without the ornament of a mortgage».

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¹) Papers which refer directly to the drainage of the wet prairie in an adjacent state are L. HEWES, The northern wet prairie of the U.S.» *Annals of Association of American Geographers*», 4 (1950) 40—57 and L. HEWES and P. E. FRANSDON, Occupying the wet prairie, *ibid*, 42 (1952), 24—50.

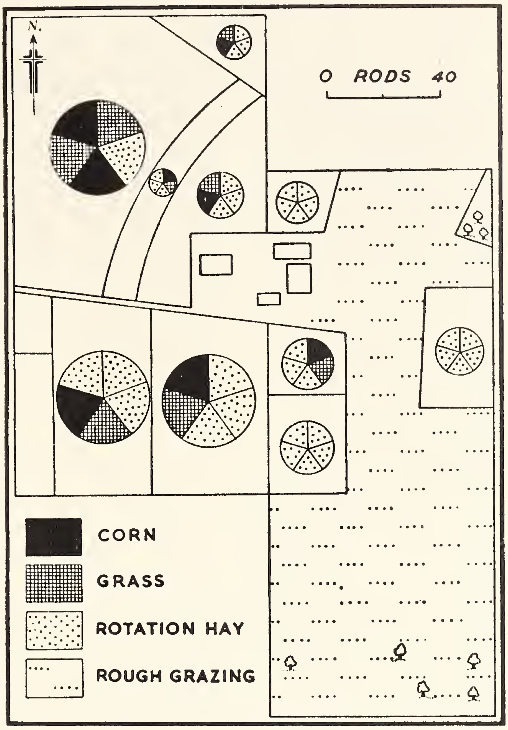

Fig. 6. A Finnish-owned farm from Dassel Township, showing crop rotation on a field basis.

Such a farm is illustrated in Figure 6 — a Finnish-owned farm in Dassel township which is the end-product of nearly a century of effort. It was staked out as a holding of 160 acres in 1857 and was purchased by its present proprietor in 1910. Within the unitary boundaries are embraced a portion of rolling moraine country with sandy loam soils subject to ready erosion on sloping land, a limited area of black humus soil, some clay and soggy hollows through which runs a creek which dries up in summer. There is no tile drainage. Indeed, most of the farm is water deficient. »It rains one day and dust blows the next», commented the owner. The system of rotation on a field basis is illustrated in the plan: there are three miles of post and wire fence. Nearly one third of the holding is maintained as »wild pasture», while one elongated field is contour-ploughed in accordance with local conservation practice. There are about four acres under small hardwood timber. The principal production is fodder. Planting corn when the oak leaves are as big as squirrel's ears comes

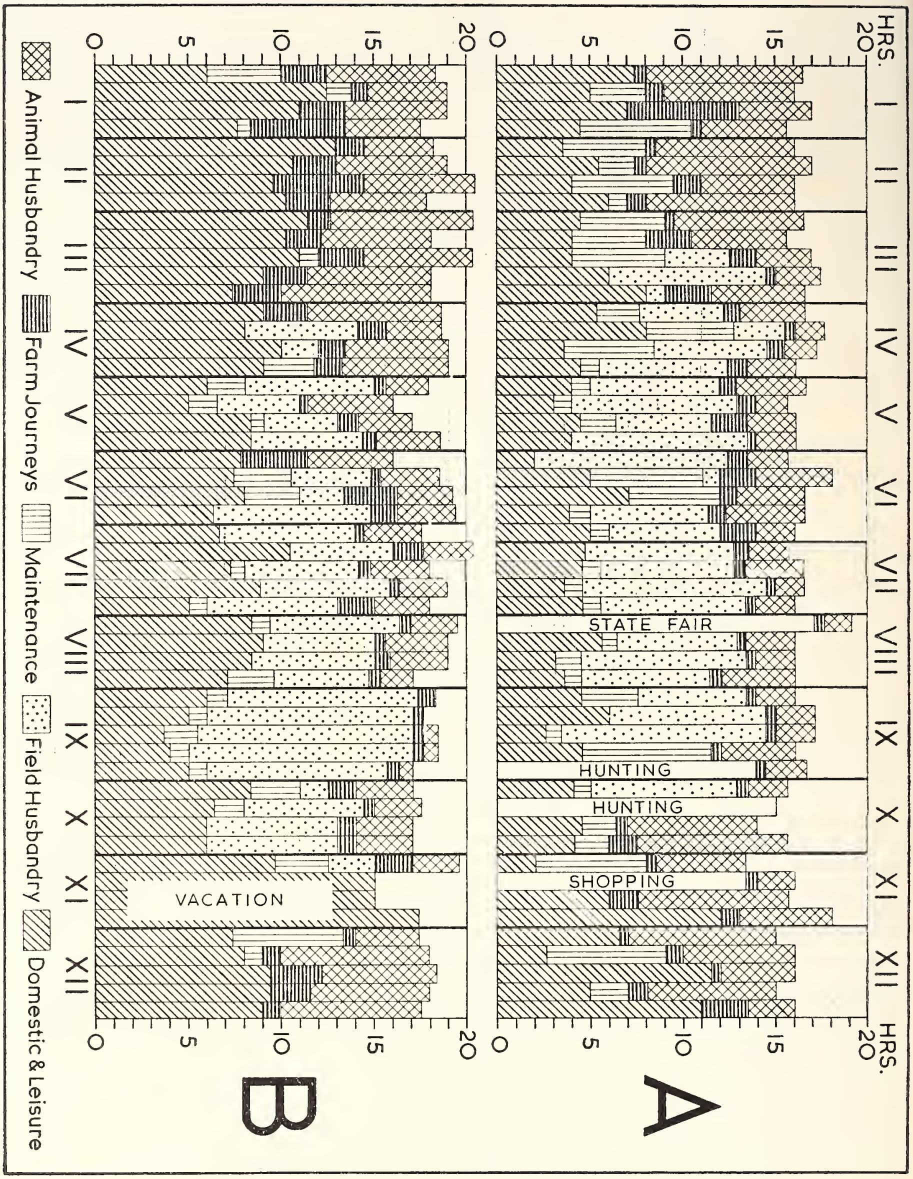

Fig. 7. Two work graphs compiled from diary material kept by Mr. Root and Mr. Pousi of Dassel township. Diaries were kept on a daily basis, one day per week. The slight variations in the weekly pattern result from a shift in the day of record keeping on one farm.

as second nature to a second generation Finnish midwesterner and the soy bean is already a key crop in his rotation. Fodder crops support a typical Minnesotan dairy herd of twenty Holsteins. Eight beef cattle represent the reverse of the coin — with meat and milk prices calling forth farm adjustments. Pigs are not kept, but there are 4—500 chickens.

Figure 7 is an attempt to adda dynamic touch to the farm scene from Dassel township. It derives from farm diaries kept by two farmers of Finnish origin. Diary A shows the pattern of seasonal activity related to the farm in Figure 6: diary B derives from a neighbouring farm. Only on one score is there affinity with the average Finnish holding — the accent on animal husbandry. It will be noted that dairy herds of 20 and 25 respectively make a continuous demand throughout the year, calling for a maximum of effort in winter. In the year under investigation, dairy cows were turned into the alfalfa/brome pasture during the first week of May and kept in overnight as from the first week in October. Beef cattle continued out of doors for several weeks afterwards — pastured on corn stalks. Fodder conservation, bulking largest in its demand on time in September, was succeeded by fodder preparation, oat sacking, corn shelling, grain milling during the period of indoor stabling.

Field husbandry was oriented to fodder crops. The diaries indicate that harrowing and disking of the seed bed began in April. May was the general month of sowing; though oats and alfalfa were sown in mid April. Already by mid June, alfalfa was being cut for silage and hay for baling. Oat combining was completed by mid August: corn ensiling reached a peak in mid September: corn picking was still being actively pursued in mid October. In mid November, ploughing until 6.00 p.m. recalled the latitude (45° N); while the distribution of chemical fertilisers continued until the end of the month. Field husbandry, in fact, was only excluded from the work programme during four months. There was no complementary forestry; for farm woodlots were insignificant.

The diaries indicated the relative mobility of the farmers. In each instance, journeys included regular daily transport of milk to the creamery. Other items included the movement of silage or grain to the mill, of fuel from town (generally coal), of hogs for shipment to the stockyards and of baled hay for export to drought areas. Mobility is an aspect of mechanisation and mechanisation made the principal contribution to the category headed »Maintenance». Building repair and fence maintenance claimed little time in comparison with tractor, combine, hay baler, corn picker, grain drill, electric batteries and such refinements as heat lamps for farrowing pens and electric clippers for trimming the cattle.

»Leisure» reflects both locality and ethnography. By night, sauna and *Suometar* are in competition with television. There are regular gatherings at the church of Suomi synod and monthly meetings of the Soil Conservation Service. Wild life is a winter attraction — with pheasant shooting followed by deer stalking and intermittent fishing for northern pike in »fish houses» erected over ice holes. The reduced pressure of work in November makes it a natural holiday month for the Minnesotan farmer for whom Californian sun is only several days away by car. To classify data is sometimes difficult. The day snatched at Minnesota State Fair is business as well as pleasure: so are the two hours spent in entertaining each month the milk tester.

In brief, the habitat which announces itself is Middle Western: the economy, distinctly American: the society, still partly Finnish — and the methodology of the diary is a means of drawing out a single tissue from the living fabric of the area.

As with most of North America, the landscape of townships like the four under review has gone through much change in a very little time. The relics of pre-colonial days are fragmentary — occasionally a rough morainic hillock or patch of swampland has escaped the modifying hand of man or blade of machine. Occasionally, a churchyard, having been protected from plough or grazing beast, preserves something of the original flora beside the burial mounds of the original colonists. It is a landscape which today displays evidence of intensive utilisation and appreciable prosperity. And among the many minority groups which have shared in its transformation, the Finns have been in the vanguard. The 1950 *Population Census of Minnesota* (Bureau of the Census, 1951) lists those of Finnish origin and their distribution is outlined in Figure 1. Recruitment from the »old country» is not lively partly because occupation of the farmland in this area is complete. In some parts of the Middle West, the Finn has gone to join the pool of unskilled labour in the towns. In central Minnesota, he has gone against the agricultural grain of his homeland and transformed himself into a skilled mid-western farmer.

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THE ENSETE PLANTING CULTURE
OF
EASTERN SIDAMO, ETHIOPIA

THE ROLE OF THE ENSETE-PLANTATIONS IN THE LOCAL ECONOMY AND THEIR SIGNIFICANCE IN THE CULTURAL GEOGRAPHY OF ETHIOPIA

BY

HELMER SMEDS

WITH 11 FIGURES IN TEXT

HELSINGFORS 1955

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Introduction[1]

One of the most conspicuous features of the ethiopian cultural landscape in large parts of the country are the usually circular-shaped, closely fenced plantations of the ensete banana (cf. fig. 1, fig. 5), a cultivated plant endemic to Ethiopia. The earlier explorers as well as the later visitors to the ethiopian highlands have been struck by these luxuriant plants, seemingly representing an exuberance of the equatorial lowland climate in the temperate air of the bleached highlands. JAMES BRUCE encountering the ensete during his travel up the *Little Abbai* in the late fall 1770 writes: »This village, as indeed were all the others we had seen since our crossing the Nile (i.e. Little Abbai) at Goutto, was surrounded by large, thick plantations, of that singular plant the Ensete, one of the most beautiful productions of nature, as well as most agreeable and wholesome food of man», and describes the plant and its uses minutely in the Appendix to his Travels, trying even to connect it with the oldest agriculture of Egypt[2]. HUGH SCOTT, a late traveller, visiting the country twice, 1926—27 and 1948—49, describes his first encounter with the ensete, when crossing the *Rift Valley* from *Shashamanni* and entering the province of *Wollamo*, as follows: »After the bleak landscapes of central Shoa, and the monotony of the acacia-bush, the immediate surroundings of Sōddu looked very beautiful. The

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[1] This article is the first report from the *Finnish-Scandinavian Geographical Expedition to Ethiopia 1953—54*, the leader of which the writer was.

[2] JAMES BRUCE: Travels to discover The Source of The Nile. In the Years 1768, 1769, 1770, 1771, 1772, and 1773. Edinburgh & London 1790. Vol. III, p. 584; Appendix, pp. 36—41.

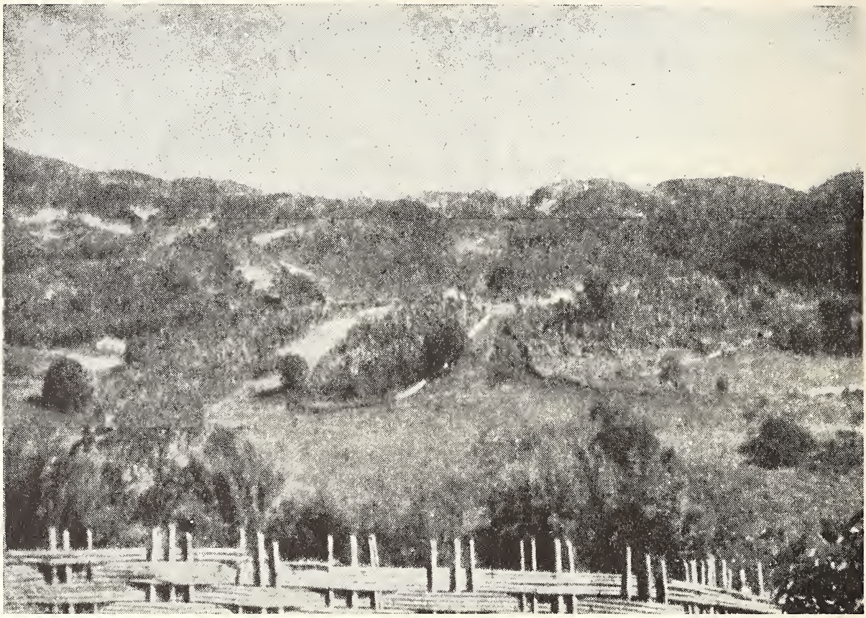

Fig. 1. Upper eastern slope of Garamba with bamboo fenced ensete plantations. Photo Helmer Smeds, February 1954.

close cultivation, the hedges of euphorbia round enclosures near the town, and the plantations of enseté-trees (Ensete edulis), with the hot bright sunshine glinting from their burnished leaves in the crystal-clear atmosphere between the October thunderstorms, all contributed to an impression of richness and fertility. I, who had never seen any such countryside in Ethiopia, felt much nearer to what I had heard of central Africa.»[1]

Harris, the english ambassador to king Sahale Selassie of Shoa in the 1840's, writes on the ensete: »towering above the enclosures of the lofty villages (it) imparts an aspect not properly belonging to the landscape, and strangely contrasting with many alpine associates»[2]. A french traveller of the last century has strikingly estimated the ensete in southern Ethiopia as a »culture d'une importance encore plus capitale que ne l'est celle du Froment chez nous».[1] An italian explorer of the last century in the Guraghe country compares the plantations to the vineyards of his homeland, when seen at a distance, or, when looked upon on at a closer range and when the lower leaves are already cut, to vaste artichoke-fields; as to the importance of the plant as a provider of food and fibre he writes: »Questa pianta è una vera manna pei Guraghi: Collo' Nsete si fa il pane, la radice lessa é superiore alla nostra patata e le fibre della foglie, dopo spogliate dalla cellulosa (mi pare), servono per farne corde, stuoje, sacchi, ecc., come vedrà dalla roba che manderó con Aprico»[2]. And a compatriot to him passing through the same country writes: »ci trovammo nell' ultimo lembo del paese dei Guraghi, popolo industre e intelligente. Sincontravano di quando in quando grandi boschi di Musa 'Nsete, disposti a filoni, coi viali puliti, con una graziosa casina nel centro del bosco, ma disgraziatamente tutto era deserto (because of the war). — Fa l'effetto d'un convento, questa campagna! Pare il soggiorno della pace! Ogni casa ha il sua orto ove si coltiva tabacco, cavoli, una specie di patata e poi sempre splendidi boschi di Muse.»[3] The french explorer of the Kaffa highland, JULES BORELLI holds the ensete to be »de toutes les plantes, celle dont les indigènes tirent le plus grand parti.»[4]

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[1] Hugh Scott: Journey to the Gughé Highlands (Southern Ethiopia), 1948—9; Biogeographical Research at high altitudes. Proceedings of the Linnean Society of London, vol. 163, part 2. London 1952, p. 128.

[2] W. Cornwallis Harris: The Highlands of Æthiopia, London 1844, vol. II, Appendix, p. 399.

The cultivation of the ensete belongs to the hoe culture of tropical Africa as opposed to the plough farming of the subtropical part of the continent, which is well represented in the northern part of the Ethiopian highland. It is a planting culture characterized not so much by the principal implement, the hoe (or related tools), as by the way of reproducing the plant by its vegetative parts, not by seeds as in the plough farming, a contrast between the two main types of farming recently stressed by CARL O. SAUER[5]. Surely the ensete can be and is sometime also reproduced by seeds, but as to the general type of its cultivation there can be no doubts. The ensete planting culture is located in the highland zone of 1.600—3.200 m above sea level, differing in this point from most of the planting cultures of Africa. It is also a remarkable thing that this plant should be the only one forming monocultures in Ethiopia. A german geographer, W. STIEHLER, has indeed recently made an attempt to place the ensete at the very basis for the development of settlement and agriculture in Ethiopia, interpreting it as a cultivated plant of the aboriginal, negritic and/or pygmé populations of Ethiopia, the cultivation of which has been taken over and combined with cattle industry by later entering hamitic peoples[1]. SAUER places a subordinate center of vegetative planting in Africa, but in the Guinea coast, and treats Ethiopia largely only as a seed center. He has though an old colonial extension of the planting hearths marked in southwestern Ethiopia on his Pl. IV, but it is not refered to in the text[2].

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[1] Cf. D. BOIS: Bananiers d'Abyssinie a feuilles rouges in Bulletin du Muséum National d'Histoire Naturelle 1930, p. 689.

[2] V. BARBIERI in a letter to the Societa Geografica Italiana of the 7 oct. 1886, cf. Bolletino della Societa Geogr. Ital., serie II, vol. XII, Roma 1887, p. 278.

[3] L. TRAVERSI: Viaggi negli Arussi, Guraghi, Ecc. Boll. della Soc. Geogr. Ital., serie II, vol. XII, Roma 1887, pp. 267—68.

[4] JULES BORELLI: Ethiopie Meridionale, Paris 1890, p. 308.

[5] CARL O. SAUER: Agricultural Origins and Dispersals. American Geographical Society, New York 1952.

Dwelling in Ethiopia from November 1, 1953 to June, 19, 1954 and having the advantage of staying in one of the most marked ensete plantation areas of the country, eastern *Sidamo*, from January, 24, to February 22, I should like in this article to describe a typical ensete-country of that area and to make some remarks on the ensete problem in general.

The Region

The *Sidamo* province of today occupies a large part of the southern Ethiopia, some 102.000 sq.kilometers, since the former *Borana* province was included[3]. The Sidamo proper consists of the northern, higher part of the administrative division. It can suitably be subdivided in a western Sidamo, comprising the sparsely populated lowland adjoining the lakes of the *Rift Valley*, and an eastern *Sidamo* consisting of the densely populated and highly cultivated highland part east of the Rift Valley, the western brim of the *Somali plateau.* If restricted to the area inhabited by the linguistic group wearing the name of sidamo, it is only the northeastern part of the highland (the triangle *L. Auasa* -N end of *L. Abbaya — Ganale Doria*) which makes up Sidamo proper[4].

The main topographical feature of this highland area is a high ridge, running NE—SW through the region, i.e. the edge of the Somali tableland. The highest parts of the ridge, the *Garamba plateau* in the north and the *Hula-Agheresalam plateau* in the south, both reach above the 3.000 m level according to the international one to one million map. The western slope is broad, the 2.000 m contour coming close to, in some places even crossing, the highroad to *Shashamanni* and *Irgalem,* the capital of Sidamo, which lies at 1759 m above sea level. The eastern slope passes into a broad plain at a height of 2.300 to 2.600 meters, traversed by the upper reaches of *Ganale Doria* (cf. fig. 11). The whole triangle is marked by large ensete plantations, with the exceptions only of the coffey plantation area round Dilla in the south, the cereal crops surrounding the amharic kattama-settlements on the Hula plateau, and the pastures of the Garamba plateau.

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[1] W. STIEHLER: Studien zur Landswirtschafts- und Siedlungsgeographie Äthiopiens. Erdkunde, band II, 1949, pp. 257—82.

[2] SAUER, op. cit., planches opp.p. 74 and p. 84.

[3] GUIDE BOOK OF ETHIOPIA, published by The Chamber of Commerce, Addis Ababa, 1954, pp. 402—3, map, shoving administrative divisions of Ethiopia, p. 391.

[4] J. SPENCER TRIMINGHAM: Islam in Ethiopia, Oxford University Press 1952, map opposite p. 1.

Rocks and Soils

The bedrock is built up by the older, largely basaltic, cretaceous to tertiary lava flows of the Ethiopian plateau[1], the underlying crystalline basement however appearing immediately to the south, in the valley of *Ganale Doria* and farther to the west, in the vicinity of *Dilla.*[2] Fractures in the trap rock form small escarpments both on the Garamba plateau and the eastern plain, up to 10 meters high, causing waterfalls in the brooks, some of which are marked on the British 1 : 500.000 map. A tuffitic texture of the rock exposed in the mule track on the steep eastern slope of the *Garamba* as well as conglomerates indicate the importance of subaerial agents in the development of the landscape. On the western slope of Garamba a breccia is observed. Whether the plateau is an isolated part of the trap, a mesa, or a separated outflow of lava on the basement of the older trap sheet, or even, to its origin a fault block, can be decided first by closer scrutiny.

The soil cover of the region is as a rule thin. On the lower part of the western slope appears a red deep soil, »the coffey soil of Irgalem», which according to MARBUT[3] should be classed as belonging to the red loams. The higher ground, including the whole eastern valley plain is covered by a thin, brownish soil, which according to SHOKALSKAYA should be classed under the group: slightly leached soils under dry forest[1]. The deep, black soils of the highland belt, between 2.500 and 4.000 m above sea level, described by BÜDEL[2], frequent still in the adjacent Bali province to the north, and predominant farther north in the Arussi province, are almost completely lacking in eastern Sidamo, owing probably to the greater length of the rainy season.

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[1] J. BÜDEL: Klima-morphologische Arbeiten in Äthiopien im Frühjahr 1953. Erdkunde VII, heft 2, 1953, pp. 151-52.

[2] Cf. the accompanying map in 1 : 2.000.000 to Giotto Dainellis Geologia dell'Africa Orientale, Rome 1943, and the description in vol. III, p. 158, p. 165 and p. 169.

[3] H. L. SCHANTZ & C. F. MARBUT: The Vegetation and Soils of Africa. American Geographical Society, Research Series No 13, 1923, pp. 192 and following. Cf. annotation in Guide Book of Ethiopia, that the red loam soils farther north are practically free of aluminium hydroxides (op.cit., p. 185), which agrees with MARBUTS conception of the african red loams.

Climate

The highlands of eastern *Sidamo* are moister than most parts of the Ethiopian highlands, owing partly to the great amount of total rainfall, but mainly to the evenness and long duration of the rainy season. There are unfortunately no meteorological stations within the region. Immediately to the north the stations *Colaris Concession* and *Mt. Abaro* offer sites comparable to that of Irgalem on the westernmost and lowest part of the region. The rainfall in mm[3] per month for the two stations is as follows (Addis Abeba added for the sake of comparing):

	Col. Concess. 1.850 m above sealevel, 40 km south of Shashamanni. Average for 17 years: 1932—39 and 1942—50.	*Mt Abaro* 1.860 m ab. sea level, an isolated hill, 10 km south of Shashamanni. Average for 7 years, 1931—37.	(*Addis Abeba,* 2.408 m above sea level. Average for 5 years, 1946—50).
I	13	28	6
II	47	57	27
III	87	110	75
IV	*129*	149	*110*
V	128	*167*	101
VI	102	111	145
VII	138	*212*	*349*
VIII	146	210	340
IX	*148*	159	216
X	68	78	32
XI	37	50	7
XII	25	17	1
Year	1.065	1.348	1.409

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[1] Cited after the map in L. DUDLEY STAMP: Africa, A Study in Tropical Development, New York 1953, p. 104.

[2] BÜDEL, op. cit., p. 144.

[3] The numbers appear in duplicated lists, issued by the Ethiopian Meteorological Service in Addis Abeba, and were kindly offered me by the Director, Eng. V. LISSICINE; the numbers previous to 1940 taken from FANTOLLI: Preliminari Del Clima Dell'Etiopia (1940).

It is remarkable that neither of these two stations have a completely dry month, whereas Addis Abeba has three months with a precipitation below 10 mm[1]. Also within the rainy season March-September the distribution of rain is remarkably even, the spring (April-May) maximum (»the small rains») being almost as high as the late summer maximum. On the contrary Addis Abeba has a small rains maximum which is only 1/3 of the big one in July-August.

As rainfall increases with altitude, it seems natural that the greater part of Eastern Sidamo should have a larger precipitation than Mt Abaro and Colaris Concession. A rough idea of this increase can be gained by comparing the annual rainfall of the four stations *Bishoftu*, *Akaki Boys School*, *Addis Abeba* and *Entoto*, lying at quite a close range, but at different altitudes, respectively 1.960 m, 2.100 m, 2.408 m and 2.900 m above sea level. The amount of precipitation, for the year 1952, was respectively 618 mm, 864 mm, 1.068 mm and 1.009 mm. The level of maximum rainfall seems thus on this slope to lie above 2.400 m, but below 2.900 m. The increase of the annual rainfall between the levels 1.960 m and 2.400 m, to judge from the 1952 numbers, seems to amount to about 75 %.

One seems thus entitled to appraise the annual rainfall of the higher western slope of *Garamba*, as well as the eastern valley plain, to be considerably higher than that of Mt Abaro and Colaris Concession, not unlikely to something little short of 2.000 mm, a number much higher than hitherto estimated for the region on generalized rainfall maps[2]. This is confirmed by the experiences made by our expedition. During our stay in *Arbigona* (8.482 feet above sea level) on the eastern valley plain, which lasted from February 6, to February 22, there were showers on an average two days out of three, often lasting for several hours, whereas during our sojourn in *Irgalem* (5.771 feet above sea level), from January 25, to February 4, there was rain on an average only one day out of three, seldom continuing for more than half an hour. Owing

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[1] Cf. Wilhelm Lauer: Humide und aride Jahreszeiten in Afrika und Südamerika und ihre Beziehung zu den Vegetationsgürteln, in Studien zur Klima- und Vegetationskunde der Tropen, Bonn 1952, pp. 33—35, and especially the map at the end of the volume, showing an area of more than 10 humid months in southern Ethiopia.

[2] Cf. Scott, op.cit., map. p. 111, which places the region between the 800 and 1.200 mms isohyetes, F. Maurette: Afrique Equatoriale, Orientale et Australe in Géographie Universelle, 1938, rainfall map of North-Eastern Africa on p. 159, which places the region between the isohyetes 500 and 1.000 mm, and rainfall map by G. Dainelli in L'Africa Orientale, Reale Societa Geografica Italiana, Bologna 1935, p. 144, which places the region between the 1.250 and 1.500 mm isohyetes.

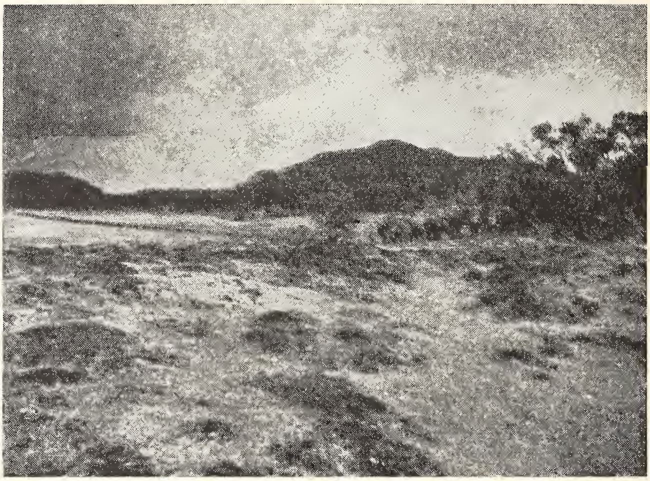

Fig. 2. Mossy knolls on the Garamba plateau. In the right foreground Erica arborea forest. Photo Helmer Smeds, February 1954.

to the higher relative humidity at the higher levels heavy dew fell every night in Arbigona and on the Garamba plateau (where I spent two nights), but in Irgalem none or only little fell. At our camping place NE of Arbigona, the ground was wet every morning, as well as the duck, which now and then was dripping wet in the mornings. Clouds gathered regularly around the Garamba plateau before noon, and once, on the morning of February 19, I had the opportunity personally to experience a descent from the fog and sprinkling rain of the plateau to the eastern valley plain bathing in sunshine. The fog level, and most likely the level of maximum rainfall, seems to lie at 2.800 to 3.000 m on the higher slopes and crest of the Garamba plateau.

The climatic contrast between the lower and the higher slope and the plateau is clearly reflected in the vegetation. On the upper slope and in the sparse forests of the plateau the branches of the trees are heavily loaded with epiphytes. The sward of Garamba was already green in the beginning of February, the first blue flowers of *Merendera abyssinca* A. Rich. glittering in the grass, and even in the Arbigona district there was a slight green luster over the landscape, as a contrast to the grey to red, dusty ground of Irgalem on the lower slope in the west. This contrast in the vegetation is not, of course, *eo ipso* a token of higher rainfall on higher levels, but due to a greater moistness in the ground, a larger relative part of the precipitation being available for the plants because of lower temperatures and lower evaporation.

The region is situated on both sides of latitude 7° N, but frosts are reported for the Garamba plateau at a height of 3.000 m above sea level. The minimum temperature for February 5, was registered at 5° C. Mossy knolls, barely 25 to 50 cm high, but 2 to 3 m in diameter, observed at 3.100 m in the western part of Garamba, might be caused by soil frosts (cf. fig. 2).

The annual mean temperature is likely to be 20° to 22° C on the lower, and 10°—12° on the higher levels, the amplitude between the coldest period in December-January and the warmest in May, being slight as in highland-climates normally.

The natural vegetation cover

The greater part of the region, indeed probably the whole of it, has originally been covered by forest vegetation. Remnants of the forest cover are still preserved on the western slope, whereas the eastern plain and Garamba are almost entirely deprived of their natural vegetation, transformed into continuous cultures and pastures as they are.

The original forest belonged to SCHANTZ *Temperate Rain Forest* of 1923[1]. Since then it has been several times renamed, one of the latest being *The Montane Forest Belt of East Africa*[2] by OLOV HEDBERG 1951. It is the two uppermost zones of this belt which are most largely represented in our region: the *Bamboo zone* and the *Hagenia-Hypericum* zone.

The subdivision made by HEDBERG is the following (bottom-upwards): a) *Montane Rain-forest zone*, b) *Bamboo zone* and c) *Hagenia-Hypericum zone* (upwards from the *Hagenia-Hypericum zone* follows the *Ericaceous, Belt*, in our region represented perhaps by the highest parts of Garamba, and the *Alpine Belt*, not represented in eastern Sidamo). SCOTT[3] has three corresponding zones for the highlands of Southern Ethiopia: (i) *lower mountain forest* (forêt ombrophile), »extending up to the zone of maximum rainfall, about 7.800 feet», (ii) *the bamboo subzone*, »from roughly 7.800 to nearly 10.000 feet» and (iii) the *highest forest* (étage des forêts superieures), »dominated by *Hagenia*, from about 10.000 feet to the tree-limit at a varying altitude» (and above the forest the heath zone from 10.000 to 12.500 feet, and the high-mountain zone, subdivided in the *Alchemilla subzone* and the *moss- and lichen subzone*).

W. E. M. LOGAN[4] has from a different point of view made a subdivision of the »types of woodland» in Central and Southern Ethiopia. His *Climatic*

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[1] SCHANTZ & MARBUT, op.cit., p. 32.

[2] OLOV HEDBERG: Vegetation Belts of the East African Mountains, Svensk Botanisk Tidskrift 45, 1951, pp. 162—70.

[3] Scott, op.cit., pp. 91—92.

[4] W. E. M. LOGAN: An Introduction to the Forests of Central and Southern Ethiopia, Imperial Forestry Institute 24, University of Oxford 1946, pp. 28—36.

Moist Woodland corresponds to the Montane Forest Belt of Hedberg. LOGANS subdivisions are: (i) *Tropical upper montane rain forest,* (ii) *Tropical high montane conifer forest* and (iii) *Tropical bamboo forest,* the last mentioned represented only by small clumps of bamboo on the *Hula plateau* at a level of 9.000 feet. Type (i) is the wettest type of forest in Ethiopia, type (ii) occupies the drier and also in general colder localities, the yearly rainfall being for the former over 40 inches per annum, well distributed over a relatively long rainy season extending up to six months or more, for the latter from 30 to 40 inches, spread over a relatively short rainy season. There could be commented on this division that the name of type (ii) is not well choosen since conifers also appear in type (i), the second subdivision of it being even named after a coniferous species (Podocarpus). It is LOGAN'S types (i) and (iii) which are represented in eastern Sidamo. The type (ii) is practically absent: I have seen the ethiopian cedar, *Juniperus procera* Hochst. only at one place in the whole of eastern Sidamo, a grove of splendid thick-stemmed trees on a northfacing valley slope in the western part of Garamba.

Beautiful groves of *Podocarpus gracilior* Pilger are to be seen inside the town-border of *Irgalem* and upwards along the slope of *Garamba* to an height of 2.200 m. Slender stems of the *Draecena* sp. decorate the deep valleys encircling Irgalem. Common trees in the western forest up to 2.200—2.400 m are *Ficus* sp., *Euphorbia* sp., *Olea* sp., *Erythrina*[1] sp., and *Polyscias ferruginea* (Harms) Hiern[2] [3]. The first bamboos emerge at a height of 1.950 m. At the 2.100—2.200 m level they are already a common sight in the valleys. As the bamboo, *Arundinaria alpina* K. Schum., is common also on the top of the plateau at a height of 3.000—3.100 m it is not possible to discern a clear limit separating the *Bamboo* and the *Hagenia-Hypericum* zones. It seems that even the *Ericaceous Belt* is not properly delimited from the *Bamboo subzone* of the forest belt, as groves of fine *Erica arborea* L., 20 cm d.b.h., exist side by side with bamboo groves in the eastern higher part of Garamba. *Arundinaria alpina* occupies mostly the moister habitats in the forest. It seems likely that it has been more common in the past[4]. The annual precipitation is likely to be well over 50 inches, a quantity hinted at as necessary for the growth of *Arundinaria alpina*[1].

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[1] In the sidamo language named *velakko.* The vowels should be pronounced as in italian, both in plant names and ethiopian place-names. Thus Addis Abeba pro Addis Ababa.

[2] In sid. *kervoni.*

[3] The collected plants have been determined by Dr. BROR PETTERSSON of the Botanical Museum of the Helsingfors (= Helsinki) University, a very valuable aid, for which I owe him my best thanks.

[4] It is remarkable that the conic hill *Afurso,* north or Arbigona, visited by two members of the expedition, is covered by a dense bamboo forest. The two summits of Garamba north of the mule track, the higher one reaching 3.367 m above sea level, acc. to the international one million map, are both forest covered up to the crest, most probably *Erica arborea,* but not excluded *Arundinaria alpina.*

The forest on the upper slopes of Garamba, from 2.800 m, and the plateau itself, consists of the following species, except *Arundinaria alpina: Hagenia abyssinica* Willd., fine exemplares especially on the eastern slope; *Hypericum lanceolatum* Lam.,[2] forming thin woods of almost pure stands in some places on the plateau; a small, 4—6 m high *Schefflera* aff. *abyssinica* (Hochst.) Harms,[3], often growing as an epiphyt; *Rapanea simensis* (Mez.) Hochst.[4] (= *Myrsine simensis*); and at a height of 2.800 on the western slope *Pavetta abyssinica* Hochst.[5], a 8 m high tree with edible berries. Common bushes are: a high *Rubus* sp. with edible, as ripe yellow berries (from 2.600 m upwards); *Senecio myriocephalus* Schultz-Bip.[6], a *Vernonia* sp., up to 4 m high; and most widespread, *Erica arborea*. Among the lower bushes is *Phytolacca abyssinica* Hoffm. common.

Solitary trees of *Erythrina Brucei* Schweinf. (a fine exemplar is standing inside the town border of Arbigona not far from the church), *Hagenia abyssinica, Brucea antidysenterica* Mill.[7], *Olea chrysophylla* Lam.[8], and bushes of *Hypericum lanceolatum* and *Senecio gigas* Vatke[9] are standing on the eastern valley plain, bearing witness of its former forest cover. A thinly forested pasture north of Arbigona has small but dense groves of *Arundinaria alpina*, thin woods of *Hypericum lanceolatum* with sparsely interspersed *Hagenia abyssinica*, i.e. the forest vegetation of the uppermost forest level although the height above sea level is not more than about 2.600 m[10].

Small fens with a vegetation of *Juncus* and *Cyperus* border the watercourses in some places, both on the Garamba plateau and the eastern valley plain.

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[5] Cf. Logan, op. cit., p. 36.

[2] Sid. *gararabichu*, amh. *amicho* and in the galla language *garamba*; the tree seems thus to have given its name to the plateau.

[3] Sid. *oronche*.

[4] Sid. *gomorcho*.

[5] Sid. *shamelcho*.

[6] Sid. *ingeshu*.

[7] Sid. *atavichu*.

[8] Sid. *mekichu*.

[9] Sid. *shokocku*.

[10] My paullin-aneroid was broken during the first climbing of Garamba, February, 5; the altitudes in the text are therefore very approximate, relying only on the British 1 : 500.000 and the international 1 : 1.000.000 maps.

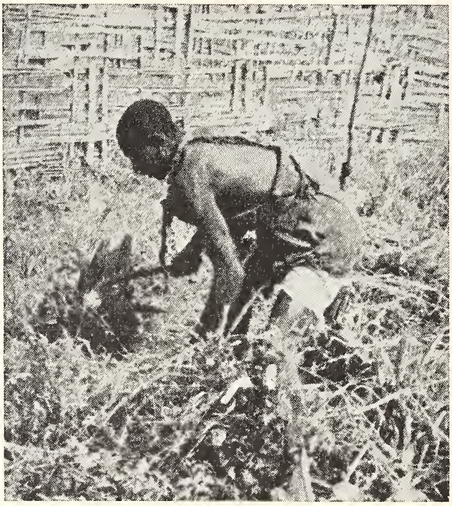

Fig. 3. The tree-mattock of Arbigona.
Photo Tor Rasmussen, February 1954.

The inhabitants

The inhabitants of the region are almost entirely of a pure Sidamo stock. Only the kattamas (= towns) are populated by amhara people. Outside Irgalem and Dilla, in the coffey plantation zone, there is also a sparse settlement of amharas and guraghes. The whole Hula plateau has settlements of amharic grain farmers, including the two kattamas, Agheresalam and Agheremariam. A few amharas are to be found on the Garamba plateau.

Physically the inhabitants do not differ much from the amharas, the population of the northern highlands in Ethiopia. The complexion is perhaps somewhat darker, and negroid features appear more often. In some individuals the hamite type, described by MONTANDON[1], or the kaffitcho type, stressed by BIEBER[2] can easily be discerned. Culturally the differences are great. The sidamos are pagan and polygamous, and their whole social and economic system is totally different from that of the amharas. Even from their close kinsmen, the likewise pagan galla herdsmen, they differ in many points. Even the clothes are dissimilar. The single garment of the men is a thick mantle of coarse cotton, alike to gallas and sidamos. But whereas the galla woman shelters herself by a big cow-hide, the sidamo woman is clothed in a skirt of hide, fastened by a girdle of ensete-fibers, and carries a small jacket of calf-skin on her shoulders, when not at work.

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[1] GEORGE MONTANDON: Au Pays Ghimirra in Bulletin de la Société Neuchateloise de Géographie XXII, 1913, pp. 133—54.

[2] F. J. BIEBER: Kaffa, ein altkuschitisches Volkstum in Innerafrika I—II, Münster & Wien 1920—23.

The ensete plantations

The Plant, *Ensete edule (Horan.) Cheesm. (= Musa ensete J.F. Gmel.).* The ensete plant is the main crop of eastern Sidamo, in fact a monoculture, since no other plants (with a regional exception to the coffey around *Dilla* and *Irgalem*) are cultivated in quantities by the habitants. It is not found growing wild in the region, but wild ensetes are reported from different parts of Ethiopia as well as from the mountains of *Kordofan* and from the lower part of the montane forest belt of *Ruwenzori*[1].

The ensete is an herbaceous plant related to the fruitbananas, and known to the foreign habitants of Addis Abeba as »the false banana»[2]. The resemblance is obvious at first sight; the greatest dissimilarities, besides the unedibleness of the fruit, being greater bulk and the larger, almost sessile leaves. Brought to Europe in 1853[3], it has since spread over a large part of the world as a popular ornamental plant[4].

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[1] LOUIS WITTMACK: Musa Ensete, Ein Beitrag zur Kenntnis der Bananen, Linnaea 3, 1867, pp. 210—23; O. WARBURG: Die Bananen Ostafrikas und ihre Verwertung in ENGLERS Planzenwelt Ost-Afrikas und der Nachbargebiete, Berlin 1895, pp. 99—100; RICHARD RUNG: Die Bananenkultur, geographisch, wirtschaftlich und kulturhistorisch betrachtet, Petermanns Mitteilungen, Ergänzungsheft 169, 1911, p. 87, HEDBERG, op. cit., p. 173, occurrence on Ruwenzori according to LEBRUN and ROBYNS. Cf. reports om wild bananas on the slope of Mt Meru, 1.800 m above the Sea in RUNG, op.cit., p. 92 and p. 98 and on the north slope of Mt Kiwu. Wild Musa Ensete are first reported from the area E of Lake Tana by Rohlfs and from Adigrat in northern Tigre by Rüppel (»unter andern sah ich hier zuerst die bekannte colossalblättrige Musa-Art Ensete, von der sich bei Bruce — — — eine gute Abbildung findet»); GERHARD ROHLFS: Meine Mission nach Abessinien, Leipzig 1882, p. 237, EDUARD RÜPPEL: Reise in Abyssinien I, Frankfurt am Main 1838, p. 341. A century later Troll reports wild ensetes growing N and S of Agordat; cf. C. TROLL & R. SCHOTTENLOHER: Ergebnisse wissenschaftlicher Reisen in Äthiopien. 1. Von Eritrea nach Gondar, Addis Abeba und Harrar, Petermanns Mitteilungen 1939, p. 232. The plant was found together with Phoenix abyssinica, indicating altitudes from 1.900 to 2.300 m.

[2] GUIDE BOOK OF ETHIOPIA, p. 231.

[3] Wittmack, op.cit., p. 223.

[4] WITTMACK mentions that the ensete plant, brought to Berlin from Kew Garden in 1861 developed into a stately, 25 feet tall plant, distinguished from all

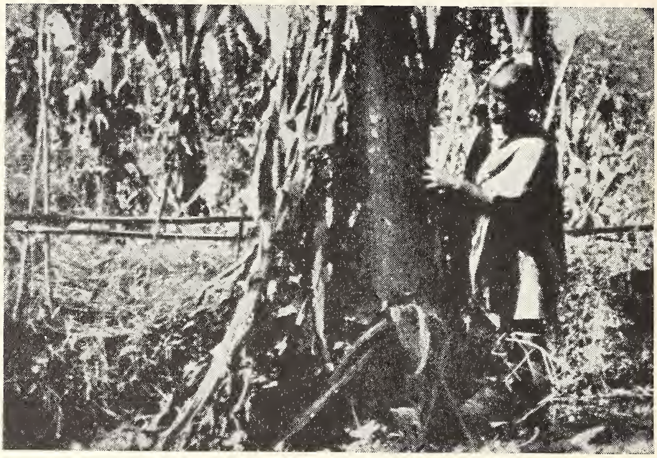

Fig. 4. View from the inside of an ensete plantation, Arbigona. Photo Helmer Smeds, February 1954.

The ensetes I saw in Sidamo, although being well known for their splendour in comparison with other ethiopian ensetes[1], did not as an average reach an height over 5—6 meters, occasional individuals reaching 8 meters. A height up to 10 meters is reported as quite common[2] and the maximum height seems to be 13 meter[3]. The first ensete raised at Kew Gardens did reach a height of 40 feet[4]. The diameter of the pseudostem formed by the leafsheaths had a diameter of only 20—25 cm, whereas the flowering ensete measured by WITTMACK in 1886 had a stem-diameter of 81 cm, but 38 cm not reckoning the leafsheaths[5].

The ensete, being an *hapaxanth* (i.e. a plant which perishes entirely after the fruitescence) and living in a highland climate, needs 3 to 6 years to build up a store of carbohydrates in the leafsheaths, necessary for the following florification and fructification. The stem of the inflorescence, in the specimen

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other bananas in the greenhouse by the splendour and magnificence of its foliage; in 1866 a french book as a matter of fact already ranked the ensete among the first of Plantes à feuilles ornamentales, op. cit, pp. 209—210.

[1] Cf. WOHLENBERG in Im Lande des Gada, Stuttgart 1936, pp. 80, 92, 142, 262; the ensete plant of *Wallamo, Amarro* and *Dorsse* is smaller than that of Sidamo (p. 262) which is said to have a height of 8—9 meters, the leaves being 6 m long and 80—90 cm broad (p. 80).

[2] STIEHLER, op.cit., p. 265.

[3] K. SCHUMANN: Musaceae in Englers Pflanzenreich, Leipzig 1912, p. 15.

[4] WITTMACK, op.cit., p. 223.

[5] WITTMACK, op.cit., p. 230.

measured by Wittmack[1], grew forth to a length of 517 cm and the spadix itself to one of 243 cm. When the seed is ripe (and the store of carbohydrates used up) the plant dies entirely, the reproduction being solely by seeds. The ensete does not thus have a perennial hypogaeous stem like the fruitbananas.

The ensete was until recently botanically reckoned as a member of the genus *Musa* (*Musa ensete* J. F. Gmelin 1791), although its first describer, JAMES BRUCE, emphatically stressed the ensetes differences to the banana, and one of its botanical examiners, HORANINOW, in 1862 made the first attempt to form a distinct new genus of it under the name of *Ensete edule*. In 1947 E. E. CHEESMAN definitely separate the african and a few asian and australian Musa species to a new genus Ensete, on genetic as well as taxonomic grounds[2].

Cheesmans description of the genus *Ensete* is as follows (points, which are of importance for the following are italicized):

> Single-stemmed monocarpic herbs, usually large. *True stem remaining short until flowering.* Leaves large, the blades oblong, commonly narrowed below into a short or rather long free *petiole,* the latter again *expanded* below *into a sheathing,* but often *not completely stem-encircling base. Sheaths* of the lower leaves sometimes short, so that the plant has a rosette habit, sometimes long and *forming a pseudostem like that of Musa. Pseudostem,* when formed, nearly always *dilated at the base.* Upper leaves passing gradually or suddenly into bracts. Inflorescence pendulous. Bracts usually persistent. Flowers many to each bract, in two rows, those of the lower bracts hermaphrodite or female, those of the upper bracts male. Free petal often tricuspidate, sometimes entire. Fruit leathery, dry or with very scanty pulp, containing relatively few seeds. Seed usually large (i.e. exceeding 1 cm. in diameter), globose or irregular, most commonly smooth, with a conspicuous, irregular and usually deeply sunken hilum. — Basic chromosome number n = 9 (whereas the genus *Musa* has n = 10 or 11)[3].

It may also be justified to quote some sentences from BRUCE's original description of the plant (important ones italicized):

> The leaves of the Ensete are a web of longitudinal fibres closely set together; *the leaves grow from the bottom, and are without stalks:* whereas the banana is in shape like a tree, and has been mistaken for such. One half of it is divided into a stem, the other is a head formed of leaves, and, in place of the stem that grows out of the Ensete, a number of leaves rolled together round like a truncheon, shoots out of the heart of the banana, and renews the upper as the under leaves

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[1] WITTMACK, op.cit., p. 228.

[2] E. E. CHEESMAN: Classification of the Bananas, I. The Genus Ensete Horan., in Kew Bulletin no 2, 1947, pp. 97—106.

[3] CHEESMAN, op.cit., p. 100.

fall off; but all the leaves of the banana have a long stalk; this fixes them to the trunk, which they do not embrace by a broad base, or involucrum, as the Ensete does.

But the greatest differences are still remaining. The banana has, by some, been mistaken for a tree of the palmaceous tribe, for no other reason but a kind of similarity in producing the fruit on an excrescence or stalk growing from the heart of the stem; — — —. The Ensete, on the contrary, has no naked stem, no part of it is woody; the body of it, for several feet high, is esculent; but no part of the banana can be eaten. *As soon as the stalk of the Ensete appears perfect and full of leaves, the body of the plant turns hard and fibrous, and is no longer eatable*: before, it is the best of all vegetables; when boiled, it has the taste of the best new wheat-bread not perfectly baked[1].

It may be added that the leaves of *Ensete edule*, although large, are stronger than those of the fruitbanana, usually withstanding the winds without bursting, which, of course, raises its value as an ornamental plant[2].

There is said to be forty different kinds of *Ensete edule* cultivated in Ethiopia, besides the *koba* variety (*Musa Ensete Gmel., var. Montbeliardi* D. BOIS 1930) differing from *Ensete edule* in the red to purple colour of the back-side of the leaf[3]. The real ensete has purple coloured leafribs. Sometimes the name *koba* is used as synonymous to ensete[4].

Ensete edule has its proper name in all the main languages of Ethiopia: *inset*[5] in sidamo, *hutta* in the kullo language of Kaffa[6], *uarki*[7] in galla, *kojo*[8] in amharic and *guna-guna*[9] in tigrean.

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[1] BRUCE, op.cit., Appendix, pp. 38—39.

[2] Cf. D. BOIS: Bananiers d'Abyssinie a feuilles rouges, Bulletin du Muséum National D'Histoire Naturelle 1930, p. 689.

[3] BOIS, op.cit., 688—89. The koba variety is also described by Harris in 1844, cf. Harris, op.cit. vol. II, Appendix, p. 399. Another specimen more different to the true ensete (small size, leafsheaths and pseudostem blackpurple) is described by BOIS under the name Musa sp?, var. Maureli. Bois, op. cit., p. 690.

[4] Guide Book of Ethiopia, p. 231; ROBERT DU BOURG DE BOZAS: D'Addis Abeba au Nil, La Géographie VII, 1903, p. 95.

[5] First vowel = sixth form in the amharic alphabet (sadis), reminds the russian yi-sound.

[6] Borelli, op.cit., p. 269.

[7] According to my annotations from Arussi and Bali. DU BOURG DE BOZAS mentions *worket* as the native name of the ensete in Guraghe, op.cit., p. 92.

[8] There seems to be a great confusion as to the origin of the native names, *inset* being sometimes quoted as amharic, and *kojo* quite often as galla.

[9] Cf. E. CHIOVENDA: L'utilizzazione della flora spontanea nelle nostre Colonie, Atti della Societa Italiana per il Progresso delle Scienze XVI, 1937, p. 353.

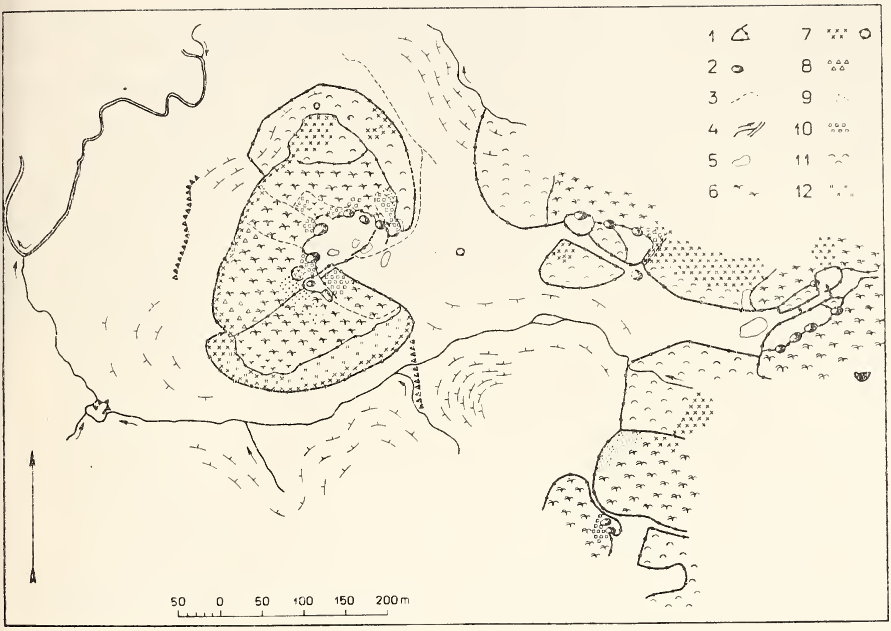

Fig. 5. The ensete plantation landscape NE of Arbigona in eastern Sidamo. 1. Bamboo fences. 2. Bamboo hut. 3. Path. 4. Brooks. 5. Heaps of manure, reclamated land. 6. Ensete plants with barley. 7. Bamboos, fenced bamboo clump. 8. »Fallow». 9. Barley. 10. Cabbage. 11. Fenced pasture. 12. Hayland (as fodder).

Cultivation

The cultivation of a plant of such a heavy bulk as *Ensete edule* must very soon involve an exhaustion of the soil, a consequence, which can be avoided only through an extensive use of manure or through an extensive fallow circulation (shifting cultivation). Another important problem to be dealt with is the reproduction. Since it is the plant-stage before florification which is important to the production of food, it must always have been felt as a loss to allow specimens to grow into the fructification-stage, so much the more because the seeds produced by each plant are few and not very reliable as to germination[1].

The problem of the impoverishment of the soil has been met with by the use of manure, i.e. the culture of *Ensete edule* is always combined with a large pastoral industry. In eastern Sidamo the ensete plantations are manured to an extent that justifies the expression man-made soil. The provision for this extensive use of manure is a large stock of cattle, and, moreover extensive pasture grounds. Of the village area mapped in the neighbourhood of Arbigona (cf. fig. 5) only 16.4 % was cultivated area, 6.0 % bamboo groves and hayfields, and 77.6 % pastures. But, this large pasture area is not enough for the grazing of the animals of the farmers, a large part of the herds being now and then, and expecially during the dry season, sent up to Garamba.

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[1] Cf. WITTMACK, op.cit., pp. 223—24.

The manure is not collected from the pasture, but from the houses, where the animals are kept during the night in separate partitions, the dung being collected in baskets and carried out to dungheaps inside the plantation, or more often in the fenced yard. The ensete plantation itself is always carefully fenced. Inside the fence are also bamboo groves, some pastures and meadows, and some minor crops (cf. fig. 5).

The ensete plants are as a rule put very close together, often so close as to make it difficult to walk through some parts of the plantation, and to make it impossible to get a wider view than 4—6 meters. Antelopes, of which *Sylvicapra grimmia abyssinica* and *Tragelaphus scriptus decula* are common in eastern Sidamo, often hide inside the ensete plantations when pursued. A row of sidamo men may walk through the plantation without succeeding in driving out the animal.

There are indeed thinner parts in the plantation, where a large part of the plants are already cut. The thinning starts when the plants are about three years old. Wholly open stretches also occur within the plantations. These »fallows» (cf. fig. 5) are however very small and few, the purpose of them being mainly to get space for the young plants and for the manufacturing work of the ensete. The narrow paths through the plantation do not claim much space.

The reproduction is by offshoots from the short stem of the six year old plants: the stem is hollowed out and covered by a mixture of soil and manure, after which it starts to push lateral sprouts in great numbers[1]. These offsets are cut and placed in well prepared plantbeds. This method of propagation is old, described already by the portuguese travellers of the sixteenth century[2]. It is, as already pointed out, the most economic method of reproduction when the main purpose of cultivation, as in Sidamo, is to take advantage of the plant in its vegetative stage[1]. The reproduction by seeds requires one to two additional years and no part of the seedplant can moreover be used as food, as the carbohydrates in stem and leafsheats are used up during the florification and fructification. An unproportionately large number of plants would moreover be necessary because of the small number of seeds in the fruit of *Ensete edule*[2]. There is another advantage to the vegetative reproduction stressed by BOIS[3], which in Sidamo however seems to be of minor importance. Through it the life of the individual is extended *ad infinitum*, and the grower can thus deliberately choose the properties he wants the plant to have, being sure they will be conserved.

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[1] Cf. Bois, op.cit., p. 689 and Borelli, op.cit., p. 309 (»La reproduction ne se fait pas par moyen des graines. Le tronc est coupé au ras du sol et recouvert de terre. Bientôt apparaissent les rejetons que l'on repique.»).

[2] Cf. quotation in Wittmack, op.cit., p. 211 of Manoel d'Almeida, relating that one stem of *Ensete edule* was forced to give 500—600 offshoots.

In other parts of Ethiopia reproduction by seeds seems to be quite common[4]. Even seeds of wild ensetes are occasionally used for sowing[5], a practice facilitated by the frequent appearance of ensete seeds on markets, not only in Ethiopia, but throughout East Africa, where they are offered for ornamental and medical uses.[6]

It is a remarkable fact that the cultivated *Ensete edule* is grown on higher altitudes than the wild plant itself grows. The habitat of the wild *Ensete edule* seems to lie below 2.000 m[7], outside Ethiopia even at a height of about 1.000 m[8], whereas the cultivated ensete according to STIEHLER in the main is restricted to the belt 1.600—3.100 meters (Guraghe 2.000—3.100, Kaffa 1.600—2.000 m)[9]. Already in 1862 LEJEAN points out that Ensete edule is a plant of the temperate regions of Ethiopia[10], and lately SCOTT has stressed the highland situation of the ensete plantations in southern Ethiopia, which go farther up the hills than any other crop, except barley, up to a point well over 9.000 feet, the ensete being comparable as to its altitudinal habitat to the *kosso* (*Hagenia abyssinica*).[1]

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[1] At the highest altitude of ensete cultivation the vegetative propagation is likely to be compulsory, since it is hardly believable that the plant could get into florification and develop seeds in a reasonable time in such a hard climate. As a matter of fact the ensete growers of Arbigona hardly know that the ensete is a flowering and fruit-bearing plant.

[2] WITTMACK, op.cit., p. 223; cf. also WARBURG, op.cit., p. 99.

[3] BOIS, op.cit., p. 689.

[4] BOIS, op.cit., p. 689.

[5] STIEHLER, op.cit., pp. 266—67.

[6] WARBURG, op.cit., p. 101.

[7] WARBURG, op.cit., p. 101, Wittmack, op.cit., p. 219.

[8] In Kordofan wild ensetes were found on the mountain Akaro at a height of 3.090 feet by RUSSEGGER, as quoted by WITTMACK (op.cit., p. 216); on the slope of Kilimandjaro wild ensetes grow at 900—1.800 m (WARBURG, op.cit., p. 99).

[9] STIEHLER, op.cit., p. 265.

[10] LEJEAN: Voyage en Abyssinie 1862—63, pp. 255—59, as quoted by WITTMACK (op.cit., p. 219).

Grown at such a high altitude *Ensete edule* often experiences frosts in winter — freezing temperatures do occur incidentally already at altitudes 2.200 to 2.600 meters above sea level[2]. It also seems obvious that the vegetative stage, during which carbohydrates are stored in the pseudostem, will be prolonged by some years, because of those low temperatures. In a favourable climate Ensete edule on the contrary yields fruits already from the fourth year[3]. In eastern Sidamo the plant exhibits few signs of starting florification in the seventh year, when it is cut down. There are some hints in the literature that *Ensete edule* never reaches the fructification stage at high altitudes owing to inadequate temperature.[4] — It should be kept in mind that the wild *Ensete edule*, from a broader point of view, also is a highland plant as all the other *Ensete* species broadly restricted to Africa, whereas the Musa species have the rainforests as their natural habitat.[5] The differentiation can be imagined to have taken place during a dry climatic phase, which forced the ancestors of the genus *Ensete* towards the moist highlands of Africa.

The reclaiming of new land usually takes place in the pasture just outside the encircling fence (cf. fig. 5). It is done by the use of two bamboo poles about 170 cm long, pointed at one end, one of the pole applied as a lever for the other. This is a one mans work.

The eastern sidamos possess only two agricultural implements, the above mentioned reclaiming poles, and the wooden mattock (cf. fig. 3), used for weeding the fields and for working the soil.

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[1] SCOTT, op.cit., p. 131 »plantations of this tree (*Ensete edulis*) are very numerous at high altitudes in these southern provinces, where, in the Gughé mountains, it grows higher up than any crop except barley», and pp. 134, 139, 143 and 144. In the northern parts of Ethiopia it seems however that the ensete plantations are located at a lower level, from 5.000 to 8.000 feet above the sea. G. K. REIN in his Abessinien, eine Landeskunde nach Reisen und Studien in den Jahren 1907—1913 locates the ensete to the second vegetational belt from 1.500 to 2.500 meters above sea level. C. REIN, op.cit., p. 214. Cf.M. TH. VON HEUGLIN: Reise nach Abessinien, Jena 1868, p. 224 and HERMANN STEUDNER: Reise von Adoa nach Gondar, dec. 26, 1861—Januar 1862. Zeitschrift für allgemeine Erdkunde 1863, p. 120.

[2] GUIDE BOOK OF ETHIOPIA, p. 125.

[3] BOIS, op.cit., p. 689.

[4] WARBURG, op.cit., p. 101 and HARRIS, vol. II, Appendix, p. 399 (»they seldom advance to flower and fruit, in consequence of the low temperature»).

[5] CHEESMAN, op.cit., pp. 98—99.

Uses

There are two main uses of *Ensete edule* in eastern Sidamo, the use of the parenchymatic tissue of the leafsheaths and the stem with its stored carbohydrates as a raw material for food, and the use of the fibrous tissue of the leafsheaths and the veins of the leaves for various purposes. A minor use is the utilization of the leaf itself for many, disparate purposes, as a waterproof roof material, as shelter, lining and covering and generally as a wrapping material.[1]

The parenchymatic tissue of leafsheaths and stem is not used as such in Sidamo, in opposition to what seems to be a quite general practice in some other parts, especially in the north of Ethiopia, where the stripped pseudostem of the young plant is boiled and eaten, as witnessed already by BRUCE[2]. There are frequent reports that the young shoots are used as vegetables[3], and also that the medulla (pith) of the inflorescence stalk is cooked and eaten[4]. HARRIS mentions even that the mealy substance of the seeds »is boiled and given to children to make them grow» and that even the fruit itself, generally disreputed as food, is »filled with delicious pulp like that of the plantain».[5]

The pulp of the pseudostem is prepared to a sort of flour[6] through a fermentation process, which seems to be common throughout southern Ethiopia[7]. The pseudostems are cut and stripped from the leaves and brought to a sort of primitive workshop close to the fermentation silo: a pit in the soil with a lining of ensete leaves, often circular, up to one yard deep and with a diameter of up to one meter (cf. fig. 6). The cutting is made by the men with the heavy knife, which every grown up sidamo man wears fastened to his girdle. The rest of the work is done by the women. The primitive workshop consists of a roof of ensete leaves, the sole mission of which is to give shade to the worker. A pole is set somewhat sloping from the roof to the ground. The working woman sits before the pole putting the leafsheaths against it, keeping them to the pole with her lifted foot, and stripping the pulp from the sheath beneath her foot by the edge of a split bamboo pole. As the work progresses, the fibers of the stripped sheath are cut by the edged bamboo half and thrown aside, the sheath is lowered and a new part of it stripped, and so on, until the whole leafsheath is finished. When a mass of scraped off pulp has accumulated on the ground as to make the work uncomfortable, it is put in the pit. The innermost part of the trunk of the older plants is a true stem, a parenchymatic tissue without fibers, and thus does not need to be stripped. It is dashed into pieces with a small wooden club, and the pieces are hurled into the silo. When the silo is filled it is covered with ensete leaves and a weight of stones about the size of a head is superposed. After a fermentation lasting from two to three months the pulp can be used for baking or for the preparing of other meals. Sometime the fermentation process may take a year, but I never heard of a longer time, as up to eight years, mentioned by TRAVERSI[1], or twelwe years by BARBIERI[2], or even thirty according to STIEHLER.[3] The best ensete flour is white and said to be procured from plants grown at lower altitudes in the neighbourhood of Irgalem, whereas the ensete flour got from high altitude plantations is of low grade and grey.[4] There are a lot of silos inside the plantations' each being opened and emptied in turn.

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[1] Cf. SCOTT, op.cit., p. 131.

[2] BRUCE, op.cit. vol. III, pp. 584—85, Appendix, p. 39.

[3] WOHLENBERG, op.cit., p. 80, HARRIS op.cit., vol. II., Appendix, p. 399, E. CHIOVENDA: Le piante alimentari nelle nostre Colonie in Atti d. Soc. It. per il Progr. d. Scienze VII, 1929, p. 522 »sono mangiate le foglie giovani specialmente i piccoli».

[4] SCOTT, op.cit., p. 131.

[5] HARRIS, op.cit., vol. II, Appendix, p. 399, cf. also Warburg, op.cit., p. 101.

[6] Flour is not the proper word for the substance prepared, which is of a almost dough-like consistence, but it is the most used.

[7] Cf. SCOTTS »a flour is made from the plant», op.cit., p. 131, WOHLENBERGS description of the process, op.cit., p. 80, CHIOVENDAS description, which holds true also for eastern Sidamo, op.cit., 1937, p. 353, and many italian authors (for example L. DE CASTRO in Boll. d. Societa Geografica Italiana 1908, p. 126, and already quoted L. TRAVERSI, the same bulletin, 1887, p. 267, and V. BARBIERI, the same bull. 1886, p. 278). A good description is also to be found in Paulitschkes Ethnographie Nordost-Afrikas, Berlin 1893, p. 161. Paulitschke makes use of information, given in Massajas I miei 35 anni di missione nell'alta Etiopia (Rome 1889) and Bianchis Alla terra dei Galla (Milano 1884), two important works, which I regret not to have had the opportunity to read.

The ensete flour is freed from the acid fermentation fluid by pressing the flour against a cone-shaped wooden stake, an implement to be found in every sidamo hut. It is then expanded on the common ethiopian large baking pan and roasted to a large, thin bread, or boiled with oil[5] to a sort of porridge, which, put into a wrapping of ensete leaf is the usual hamper food of the sidamos. The ensete bread is eaten together with a boiled cabbage salad.

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[1] L. TRAVERSI, Bolletino d. Soc. Geogr. Italiana, 1889, p. 720.

[2] BARBIERI, op.cit., p. 278.

[3] STIEHLER, op.cit., p. 266.

[4] This should be compared to BARBIERIS statement, that the quality of the ensete flour depends on how long it has fermented.

[5] Probably oil from the commonest ethiopian oil plant, nug, *Guizotia abyssinica* Cass.

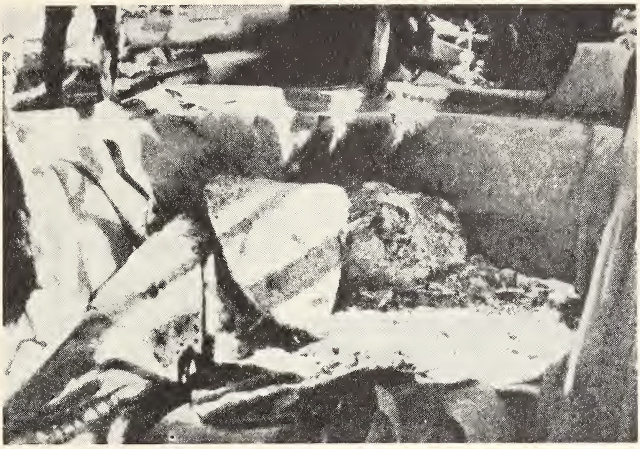

Fig. 6. Silo inside the plantation. At the left upper corner cut leafsheaths, Photo Helmer Smeds, February 1954.

The fibers set aside during the stripping are used as such, when dried, for the making of ropes and threads. The method of extracting the fibers by putting the stems in water, mentioned in the GUIDE BOOK OF ETHIOPIA as typical for Sidamo[1], is not used in the *Arbigona* region.

The main use of the leaves is as a thatching material, between layers of split bamboo, to make the roof water proof, but there is a number of minor incidentical uses, such as rainshelter, as table cloth, as coverings etc. The leaves are not used as cloths as mentioned by MONTANDON from *Kaffa*[2], or »painted with different colours like Mosaic work», as mentioned by BRUCE at the market place of *Sacala* in *Maitsha* at the *Little Abbai* river.[3]

Age and origin of ensete cultivation

As mentioned above, STIEHLER has expressed the view that *Ensete edule* is one of the oldest cultivated plants of Ethiopia. According to him the ensete planting culture has been the basic economy of negroid, if not even pygmoid tribes, which are the aboriginal population of the ethiopian highlands. This culture was spread over the whole plateau up to the Takazze line, and it was taken over by the early kuschitic immigrants, but pushed back by the later semitic immigrants from the north with their plough agriculture. Small islands of ensete cultivation remain in the north, being a small remnant of formerly much more extensive cultivations.[1]

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[1] GUIDE BOOK OF ETHIOPIA, p. 232.

[2] MONTANDON, op.cit., p. 110.

[3] BRUCE, vol. III, p. 589.

The first objection to the conception of an old ensete cultivation is that, although like the fruit banana reproduced in a vegetative way, the ensete has not lost its capacity of sexual reproduction. *Ensete edule* has seeds, which if sown, give full grown plants. It should be reminded that the cultivated *Ensete edule,* unlike the cultivated *Musa* sp. always has been reproduced by seeds. To judge from the first trials in Europe some difficulties are however experienced in the propagation through seeds[2]. There might be great differences between the different lines of the plant, in particular between those from the areas of vegetative and those from the areas of seed reproduction.

There are other circumstances which are more favourable to STIEHLERS conception. It is remarkable, as already stressed by RUNG and to a lesser degree by WARBURG, that *Ensete edule* is looked upon as a plant possessing magic qualities[3]. CHIOVENDA mentions that ensete plants always are to be found in the vicinity of the churches, and one of the jesuit paters from the seventeenth century that *Ensete edule* is conceived as an human being, which if hurt in the stem, lets out a wailing sound[4]. The seeds have served as tokens of tribute from subjugated peoples[5], which, of course, seems to support the also otherwise very plausible idea that the ensete has been a cultivated plant of the highlands already in the time when the semitic immigrants brought the seed-farming and the plough thither from southern Arabia. It is noticeable that there are special names for *Ensete edule* both in tigrean and amharic, a witness perhaps that the plant was extensively cultivated in the northern part of the plateau, in Tigre and Eritrea, at the time of the coming of the immigrants more than two thousand years ago[6]. CHIOVENDA[7] mentions the ensete as »frequentemente coltivata» both in Ethiopia and Eritrea in a work of 1929.

The main areas of cultivated ensete are however in the southern part of the highlands, with centers in Guraghe and Sidamo proper[1]. Here are regions, the whole economy of which depends on *Ensete edule*. As to the use of the plant, there is a difference between the northern and the southern parts of the ethiopian highlands. In the north the edible parts of the plant are cooked and eaten as such; in the south a flour is prepared by a fermentation process. The flour can be stored and baked to bread, a difference of great principal importance, since the fermentation process has made it possible to lay up stores of food, and given the people practicising it a market commodity[2]. It seems obvious, also, on this ground, that the ensete cultivation has originated in the south. In this matter some consideration should be given to the relation of Bruce,[3] that Ensete edule originally was brought into the Maitsha country from the old sidama kingdoom of *Enarea*, situated just northward of *Guraghe*,[4] where the ensete as far as known has played the role of a staple food and monoculture.

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[1] STIEHLER, op.cit., pp. 267—68, 273—74, 277—80, and Map. 1.

[2] WITTMACK, op.cit., p. 223.

[3] RUNG, op.cit., p. 83 and following, Warburg, op.cit., p. 101.

[4] CHIOVENDA, op.cit. 1929, p. 552. LINCOLN DE CASTRO: Etiopia, terra, uomini e cose, Milano 1936, p. 32.

[5] CHIOVENDA, op.cit. 1937, p. 353.

[6] TRIMINGHAM, op.cit., p. 7.

[7] CHIOVENDA, op.cit. 1929, p. 551.

An investigation and study of the many names the plant has in Ethiopia. would perhaps be illuminating as to the origin of *Ensete edule* cultivation. Stiehlers theory of a negro origin is not supported by the names the plant has in East Africa, as quoted by Warburg[5], but those names are incidentically found in the literature and not the result of an investigation.

The imaginative James Bruce conceived the idea that *Ensete edule* is identical to the first cultivated plant of ancient Egypt, erroneously mistaken to have been the papyrus by Horus Apollo[6]. Recently a botanist, Mrs Laurent-Täckholm of the Cairo University, has tried to identify *Ensete edule* with a common plant design on the *Naqada* pottery from Upper Egypt, dating from the Middle Predynastic Period, the most remarkable feature of which is a big, hanging inflorescence and a ring at the top of the stem pointing out the part employed of the plant. She also compares the ensete to a hieroglyph, known among the egyptologists as »the plant of the south», a sign characterized by a pendent top and 2 pairs of basal leaves and a somewhat swollen base beneath the leaves[1]. She puts the cultivation of *Ensete edule* in the Nile valley against the background of a supposed neolithic wet phase due to increased precipitation in the Ethiopian highlands. Resulting in a large extension cf swamps in the Nile valley this forced the habitants to move to the outward edge of the flooded plain, and to cultivate *Ensete edule,* which by BRUCE is described as a plant of a marshy habitat. With the regress of the floodwater and the drying up of the marshes the wheat and barley reseized their ancient place as the main cultures of the Nile valley, and *Ensete edule* withdraw to the south, to its proper home in Ethiopia, becoming extinct in Egypt. — This is an extremely interesting conception, and not immediately to be rejected. However it seems difficult to match this supposed ensete lowland culture of the Nile valley with the fact that *Ensete edule* today decidedly is a cultivated plant of the highlands. So much the more, as BRUCE's statement that ensete is a plant of marshy habitats does not seem to agree with its habits in other places of Ethiopia, at least not in Sidamo. *Ensete edule* is a plant of a moist climate, i.e. of the moist highlands of East Africa, but not a plant of a moist or marshy habitat.

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[1] Cf. Guide Book of Ethiopia. p. 231.

[2] Guidi mentions that an export of ensete flour from Sidamo is directed towards *Djam-Djam, Arussi* and *Borana*. op.cit., p. 383. Also Bruce stresses the importance of the ensete flour as a market commodity, Bruce, op.cit., Vol. III, p. 589.

[3] Bruce, op. cit., vol. III, p. 584.

[4] Trimingham, op.cit., p. 66, note 3, p. 73, note 2. Cf. Amilcare Fantolli: Una recente missione in A.O.I., Boll. d. Soc. Geogr. Ital. 1939, p. 511, where he mentions ensete as the basis »del alimento locale» in the valley of *Gogeb*.

[5] Warburg, op.cit., p. 99. The names are *m'siguah, embiri* and *matambul*.

[6] Bruce, op.cit., Appendix, pp. 1 and 41.

Minor crops

A never missing crop inside the ensete plantation is the cabbage, *Brassica integrifolia v. carinata* O. E. Schultz[2]. (cf. fig. 7). It reaches a height of 1.5 to 2 meters. The leaves are cut when needed, and this cropping of the plant may last very long, as the plant, according to an information, collected by SCOTT[3] in the *Gughe* region, may reach an age of three to four years. The cabbage is planted close to the huts (cf. fig. 5), to be within every day reach. The leaves are boiled in the great earthenware ethiopian pots, the *inseras,* adding a small amount of water, and the salad or porridge thus procured is eaten with the ensete bread. The Garamba farmers are forced to buy ensete flour, but they cultivate cabbage in quite large quantities.

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[1] LAURENT-TÄCKHOLM: The Plant of Naqada. Annales du Service des Antiquités de l'Égypte, 1951.

[2] Cf. CHIOVENDA, op.cit., 1937, pp. 353—54.

[3] SCOTT, op.cit., p. 144.

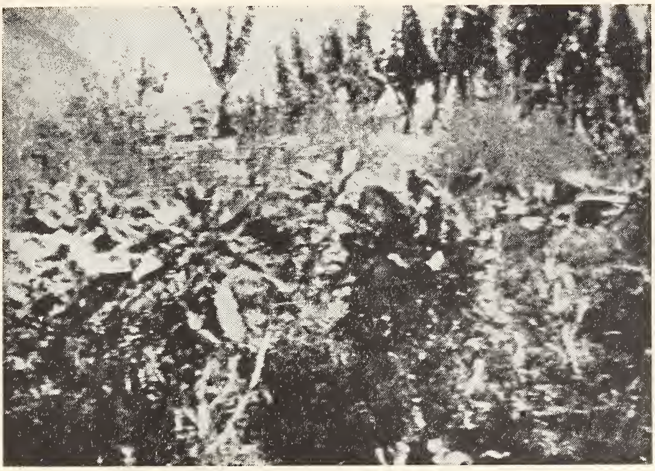

Fig. 7. Plantation of cabbage inside the ensete plantation.
Photo Helmer Smeds, February 1954.

Another crop often met with, is the barley, *Hordeum intermedium* Körn[1]. It is however cultivated as a rule only in small amounts, often only with the intention of paying the amhara landowner in this grain, indispensable for the making of the favourite amhara beer, *talla*. The greatest part of the barley sown in the village, mapped by me, belongs to an amhara man who through marriage is a member of the village group and inhabites the southernmost hut (cf. fig. 5). A curious feature is that the treshing is made by the treddling of men. On the Garamba plateau the barley is, together with cabbage, the sole crop. It is cultivated in carefully fenced and amply manured small fields close to (but separated from) the huts.

The Bamboo

The bamboo, *Arundinaria alpina* K. Schum., is a plant of great importance in all the parts of the Ethiopian highlands where it occurs. This holds true also in the bamboo region of eastern Sidamo. One may see men with a single heavy bamboo trunk, or with a bundle of many tiny bamboo poles, on their heads strive down the slopes of *Garamba* towards the market in *Irgalem*,

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[1] Cf. A. A. ORLOV: The barleys of Abyssinia and Eritrea. Bulletin of Applied Botany, of Genetics and Plant-Breeding, vol. XX, 1929, pp. 316—17, Leningrad.

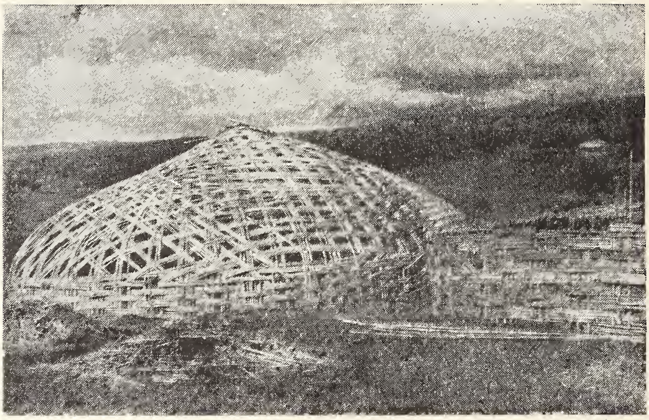

Fig. 8. Bamboo hut under construction.
Photo Helmer Smeds, February 1954.

and one may also see horses with a row of bamboo trunks fastened on each side being driven towards the open plains north of *Arbigona* and *Cocossa.*

The bamboo of eastern Sidamo may be characterized as almost a cultivated plant. The groves of bamboo, even small clumps, are thoroughly fenced against the cattle. It is a common practice that the bamboos are planted inside the ensete plantation fence (cf. fig. 5). The bigger bamboos are regularly trimmed, the branches being used for strengthening the fences.

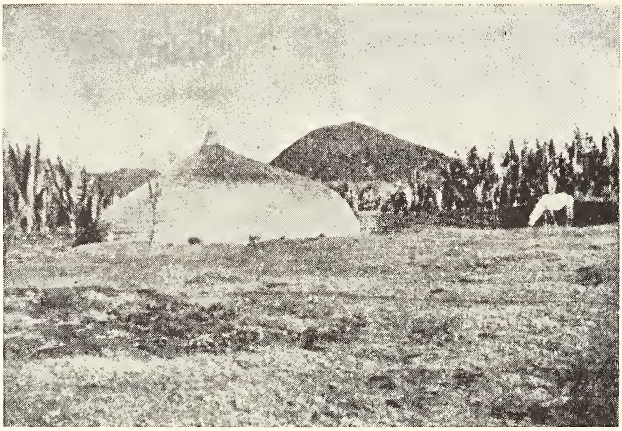

Fig. 9. Bamboo hut with the ensete plantation in the background and the fenced yard in the foreground. Afurso to the right, over the hut.
Photo Helmer Smeds, February 1954.

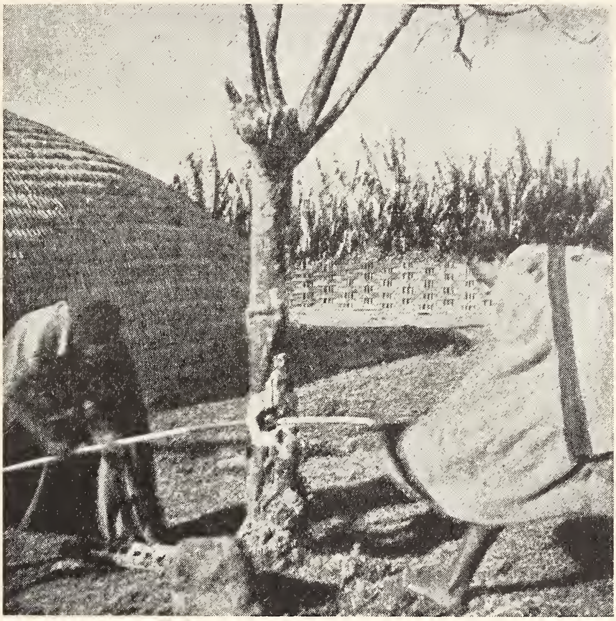

Fig. 10. Smoothing of bamboo pole.
Photo Helmer Smeds, February 1954.

The plant has manifold uses. The first and most important is as a construction material. The spacious sidamo huts (elliptical, the long axis up to 16 meters) are built of bamboo, the greater trunks serving as pillars for the roof which is constructed of split bamboo, knit together (cf. fig. 8 and 9). The important fences are all made of bamboo poles and split, knitted bamboo (cf. fig. 8). The digging pole, used in reclamation, is, as already said, made from bamboo. So are also the spearhandles, the bamboo pole intended for that use being previously rubbed in a treehole (cf. fig. 10) so as to carve off the internodial knobs. A very important use is that of water transport barrels. For that intention the nodial segments inside a big bamboo pole are broken. The barrel thus obtained may be two meters long, and carry 10—20 liters of water. The mouth of the barrel is obliquely cut to enable a quick filling when the barrel is put mouth upstream in a brook, and to facilitate the transport with the pole resting almost horisontally on the shoulder of the porter. Inside the hut the bamboo barrels are placed leaning against the wall, and the water when needed poured in smaller short, bamboo barrels, also with an obliquely cut mouth, to facilitate their use. The advantage of the bamboo barrel is not only one of easier transport, so strongly contrasted to the usual, toilsome water transport in Ethiopia, but also one of keeping the water fresh and cool for a long time.

The pastoral industry

In eastern Sidamo the domestic animals constitute an important part of the economy; the dung, playing, as already stressed, an indispensable role in the ensete cultivation system. Horses, asses, mules, cows, sheep and goats are kept, but not fowl, the keeping of which in Ethiopia is a speciality of the amharas.

During the night the animals are kept inside the hut, in about 1.25 to 1.50 meters broad partitions, constructed as bamboo fences, and starting from one side of the hut, which is straight. The opposite curved wall and the farthest bamboo fence enclose the kitchen and the dwelling place for the human habitants of the hut. The cows are milked inside the hut.

The cattle are of middle size, usually shorthorned, the commonest colour being black with white head (or at least face). But brown to white cows with brown spots are also common, and grey coloured do occur but rather as an exception. Just North of Arbigona I once reckoned 54 cattle with black or black-white colour out of a herd numbering 98 animals. The cattle are the puckled zebu, originated in India[1], the only to be found in Ethiopia nowadays, the primarily existing *Bos Taurus* being common in northern *Habesch* still at 200 to 300 A.D.[2] It differs however widely from the typical, longhorned galla cattle, described by Salt from *Gibba* in *Tigre* in 1814[3], and in the actual Ethiopia common only in *Borana.* Both the sheep and the goats are small. The former are of the fat tail type, the colour varying from yellow and white to grey and black, a white coloured lamb with yellow spots being quite common, especially on the *Garamba* plateau. The horses are also small and light coloured. Beautiful horses were to be seen on the western slope of Garamba. The asses are more common than the horses. In the village mapped I reckoned 9 horses to 7 huts, whereas the number of the asses were at least double. Mules are very rare, evidently not bred in the region, but imported from the north.

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[1] Sauer, op. cit., pp. 93—94.

[2] Stiehler, op.cit., p. 263.

[3] Salt, op.cit., p. 259.

It seems clear from the character of the pastures as well as from the general outlook of the animals that the pastures are overstocked. The village mapped elevates all in all about a hundred pieces of domestic animals, which gives 5 animals to the hectare, or 2 to the acre, a number which is high even to the standards set by commercial grazing in Europe or North America. Compared to the african rules it seems to be a sign of a quite uncommon overstocking. According to Gourou 1.5 cattle per hectare is considered as a very serious overstocking in Ruanda-Urundi, and the average of 1,2 cattle per hectare in the Nandi country of Kavirondo (NE shore of Lake Victoria) is held to be very high[1]. The commonest pasture grasses[2] are of the genera *Pennisetum* and *Andropogon*, a species of the later, *A. abyssinicum* R. Br., being known in the whole Ethiopian highland as a good pasture for cattle, *ye lami sar*, the cows grass. On the Garamba species of *Agrostis*, *Deschampsia* and *Festuca* are common. The most nutritious part of the fodder is however constituted by herbaceous plants, particularly by plants of the leguminous family. On the pastures of the eastern valley plain a *Trifolium* sp. with big, pink flowers and the *haiso*[3], *Parochetus communis* Hamilt., are quite common.

The greatest quantity of valuable pasture plants are however to be found on the sward of the *Garamba plateau*. It is no wonder that the animals regularly are brought up to the plateau from the overcharged pastures of the eastern valley plain to recover strength. The cattle kept by the inhabitants of the plateau are beautiful, fat and shining, with great hanging puckles and counters. The commonest plants of the Garamba sward are: *Parochetus communis*, three species of *Trifolium*[4], *Trachydium abyssinicum* (Hochst.) Benth. et Hook.[5], *Monopsis stellarioides v. Schimperiana* E. Wimm.[6], *Wahlenbergia silenoides* Hochst., a small *Alchemilla* sp.[7] (Steudneri?), *Viola Eminii* (Engl.) R. E. Fr.[8], *Hypericum peplidifolium* A. Rich., *Merendera abyssinica*, *Oxalis corniculata* L., *Geranium simensis* Hochst,[9], *Swertia*

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[1] Pierre Gourou: La densité de la population au Ruanda-Urundi, Bruxelles 1953, pp. 104—107.

[2] Cf. Adriano Fiori: Analisi botaniche de fieni dell'Impero, Firenze 1940 (Relazioni e monografice agrario-coloniali 58), p. 23 and following.

[3] Name in the sidamo language. Said to be a good fodder for cow and sheep alike.

[4] *Gorochichu*, very good pasture.

[5] *Greimachichu*. Pasture only for sheep.

[6] *Aisichu*. Good pasture.

[7] *Dallabichu*. A good pasture for cattle.

[8] *Shillafu*.

[9] *Shillu*. A good pasture.

minima Gilg., a tiny *Kalanchoe* sp. (*K. glaberrima?*), a *Polygala* sp. (*erioptera DC?*), a small *Ranunculus* sp.[1] (*R. oreophytus?*), *Gerbera Schimperi* A. Rich[2]., and a common *Cerastium* sp. Of these, seven are noted as good pasture plants, and four of those, leguminous, with a high protein content. It should be added that a broadleaved *Convolvulus* aff. *Schimperi* Engl.[3] on the Garamba plateau is collected as fodder for sheep and goats. The habitants of Garamba have large cattle herds and milk plays for them a still greater role as food than on the eastern valley plain. Up to 50 cattle can be kept inside the hut, and there is often a separate stable close to the hut, which enables the highlander to receive cattle from the habitants of the neighbouring lower lands.

A great part of the cash income of the ensete growers is to be gotten from cattle; by selling young animals, hides and skins. The meat is not much appreciated, even if not despised as among the galla herdsmen.

Population density

The ensete regions are among the densest populated in the whole of Ethiopia.[4] According to GUIDI[5] the population density of the southern part of eastern Sidamo rises to 70 habitants per sq. kilometer in some districts, and WOHLENBERG states a report that three ensete plants are credited to give enough food to feed a person for one year.

It seems that the population density in the region of *Arbigona* is still higher than that given as maximal for the southern part of eastern Sidamo by GUIDI. An amharic grazmach in the town of Arbigona reported to us that there are 300 people living on his 5 *gashas* of land (1 gasha = 40 hectares) N of Arbigona, which would give a density of 150 habitants per sq. kilometer. The village which I mapped (cf. fig. 5) has 35 habitants living on a land measuring about 20 hectares, which gives a still higher density, 175 habitants to the sq. kilometer. This density is however far from the highest reached in some African planting culture regions, as for example on the slopes of Kilimanjaro (273 hab. per sq.km), on the shores of Lake Victoria (354—475 hab. per sq.km) and in some highland districts of Ruanda-Urundi (311—461 hab. per sq.km).[1]

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[1] *Kintau.*

[2] *Bullachu.* A bad pasture.

[3] *Madichu.*

[4] Cf. STIEHLER, op.cit., p. 266.

[5] GUIDO GUIDI: Nel Sidamo Orientale, Boll.d. Soc. Geogr. Italiana 1939, p. 377.

If three fullgrown ensete plants give food for one person for a year according to WOHLENBERG[2], and the age of the cropped ensetes is estimated on the average to be five years, the space taken by fifteen plants in the ensete plantation is the living space needed by each person of the population. In the village mapped (cf. fig. 5) the share of the ensete planted ground held by each of its 35 habitants is about 600 sq. meters, which would make a space of about 40 sq.meters for each of the 15 specimen of *Ensete edule*, supposed to be grown on that share, a rather large figure, even taking into account that there are many thinly planted parts in the plantation. An estimate of one plant per 10 sq.meters of ground must be taken as a maximum, as to the ensete plantations of the Arbigona district. According to this, every person in a village as densely populated as the one mapped can reckon about 60 plants as his share, and if the age before cutting is estimated, as an average, to five years, he can reckon to get food from 12 ensete plants per year.

The three economies of Ethiopia

The Arbigona district is situated at a point where the three main cultures of Ethiopia, — the three main ethiopian economic systems — come close together. No 1 is the planting culture, a true African economy, represented in eastern Sidamo by the ensete plantations. No 2 is the nomadic cattle herding, largely withdrawing from the highlands where it won a large extension during the great galla invasion from 1540 onwards, being from the beginning an economy of the dry lowlands. No 3 is the amharic-tigrean ploughing culture and seed farming brought to Ethiopia by immigrants from southern Arabia during the first millenium before Christ. This newcomer has slowly but steadily progressed towards the south, conquering lands from planters and cattle herders equally. The christianization and the conquering bv plough of the highlands have gone hand in hand. And the process is by no means finished.

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[1] Cf. CLEMENT GILLMAN: A Population Map of Tanganyika Territory, Geographical Review 1936, p. 358; PIERRE GOUROU, op. cit., p. 52 and MARCEL LARNAUDE: Un haut pays d'Afrique, Revue de Géographie Alpine 1950, pp, 466—68.

[2] G. WOHLENBERG, op.cit. p. 80.

After the occupation of the new provinces in the south by emperor Menelik a colonization of those new lands started. Plough farmers from the overpopulated highlands in the center and the north of the empire poured into the new lands. Especially since 1920 this pioneering activity has been strong. The northern part of Arussi is today almost entirely turned into ploughing country, and pioneering farmers are to be found in the whole south of Arussi except the center of the *Albaso* plain and the valley plain of *Uabi*. Even in *Bali* south of Uabi there is a widening pioneering fringe around the larger *kattama*-settlements, as *Doddola* and especially *Goba*. In *Serofta*, a smaller kattama, some 20 kilometers WSW of Doddola, there is a small cultivation of wheat, but from there to the ensete area extends a pure cattle country unbroken by fields. It is a region of large open pastures inhabited by galla herdsmen, the small villages of which dot the plain and are visible even at a distance because of the large circular pens into which the cattle is driven for the night. As the pens are removed regularly a pattern of circular areas from black to deep green in colour surrounds the huts. The coexistence of sidamos and gallas in this region is of old date. As a matter of fact the tribal tradition points out the »mountain chain east af Lake Abaya (Margherita)» as the original centre of the gallas.[1]

This cattleherding area stops abruptly only one kilometer N of *Arbigona* where the last galla village with its pens is situated (cf. fig. 11). As Stiehler[2] has pointed out the ensete cultivation is tied to the sidama peoples, foremost to the sidamo proper and to the guraghe. The nomadic cattleherding of the highlands is as clearly attached ethnically to the gallas. This seems to be the simple reason for one of the most distinct borders in the cultural landscape of southern Ethiopia.

If the map on the extension of the ensete cultivation given by Stiehler[3] is exact even in details it would seem that there has been a slight extension of ensete planting (and Sidamo people) from about 1940 until 1954; but this is hardly probable, the common account being on the contrary that the gallas are the advancing part. Some ensete is cultivated north of the sidamo settlement, inside the Bali province as marked on the map, fig. 11. The ensete plantation on the slope of *Mt Fasil* NE of *Goba* is young, but this is a special story: a local mohammedan witch man started a success-

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[1] Cf. Trimingham, op. cit., p. 93. Cf. also his maps, pp. 64 and 181.

[2] Stiehler, op.cit., p. 273.

[3] Stiehler, op.cit., map. 1.

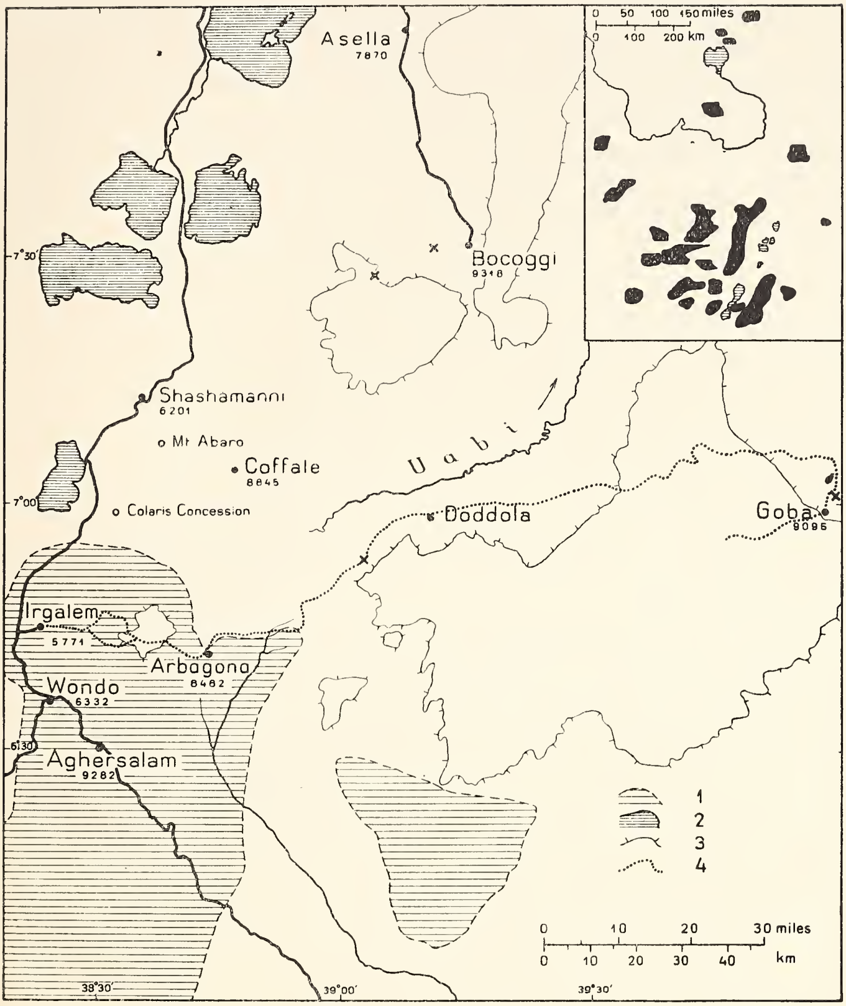

Fig. 11. The ensete planting culture of Eastern Sidamo. 1. Area with common ensete plantations (after Stiehler, however with some corrections in the part of the region visited by the expedition). 2. Lake. 3. 9.800 feets contour. 4. The track of Finnish-Scandinavian Geographical Expedition to Ethiopia in 1953—54. (Inset map of the ensete areas of Ethiopia).

ful miracle-mongers business on this spot in the forties, and an increasing lot of converts has for that reason settled down here. Some of the converts originate from the partly mohammedan ensete regions to the south, and a quite large plantation of *Ensete edule* has been started here, far away from the continuous ensete cultivation area of Sidamo.

In the Arussi province, far to the north, some ensete plantations can be seen sporadically. It is usually a sign of guraghe colonists from the west which have brought with them this plant from their home country. Thus two quite large ensete plantations are to be found close to the caravan track from Asella westwards to Dugda, both owned by guraghe immigrants. — More surprising is that the ensete planting practise is to be found also among some amhara colonists (cf. fig. 11). Thus I saw an ensete plantation of 46 plants, only four years old, at a great amhara farm (two gashas) at *Kongi* in the *Boccoggi* district, which was owned by Ato Basha Daressa, a colonist from *Shoa,* who arrived here at the reign of Empress Zauditu in the middle of the twenties. At Ato Töklu's farm about 3.000 meters above sea level on the slope of *Mt Lencha* I met a second ensete plantation consisting of about 50—60 plants. This one also was of recent origin, the colonist himself arriving in 1937 and starting to clear his fields from virgin forest. He imported his first ensete plant from Sidamo. A reason given for the cultivation, is the wholesomeness of the ensete food. The evidence of ensete plants, cultivated for food in *Coffale,* a kattama on the Arussi side of the Uabi plain, is given by a swedish missionary in 1930.[1]

It seems thus that the picture of a continuing regress of the cultivation of Ensete edule given by STIEHLER[2] may be a little exaggerated. It is, of course, true that the amhara and the seed farmers of the central and northern highlands spontaneously despise the ensete food, as pointed out by many authors.[3] But it is also true that, when living for a longer while among the ensete planters, they will take over the custom of eating ensete food and cultivating *Ensete edule.* As a matter of fact this agriculture can be rated as superior to the seed farming of the central and northern highlanders, and this superiority is the main reason why the ensete regions as a rule have withstood the amharic colonization from the north, whereas the cattle herding areas have succumbed to it. The superiority is one of maintaining the fertility of the soil through extensive use of manure. Foremost however it is that the ensete planting culture can support a denser population than the seed farming. It is worth while to notice that a german scientist like WARBURG in 1895 recommended trials with this valuable food plant in the highlands of (the then German) East Africa.[4]

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[1] AXEL B. SVENSSON: Genom Abessinien med Expresståg och karavan. Stockholm 1930., p. 248.

[2] STIEHLER, op.cit., p. 271, p. 274.

[3] Cf. TRAVERSI, op.cit., 1886, p. 278.

[4] WARBURG, op.cit., p. 101.

As the ensete food also is deservedly highly appreciated for its health stimulating qualities, a fact which is easily evidenced by the good physical outlook of ensete-eaters, like guraghes and sidamos, an investigation of the nutritive value of this food and its vitamine contents (probably increased by the fermentation process) might be well worth wile to undertake. A propagation of the ensete cultivation in the southern parts of the Ethiopian highlands together with a study of the different kinds of Ensete edule grown in Ethiopia could have ample consequences for the wellbeing of its peoples.

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